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# Interdisciplinary working practices: can creative dance improve math?

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**ABSTRACT**

This study is integrated in the field of Dance in Education, focusing on the instrumentalist aspect of art. We focused on creative dance as a catalyst to learn Mathematics' contents. This interdisciplinary work can enhance the learning, as far as the understanding of Mathematics' concepts is achieved through the body and revealed by expressive and creative movement. The main purpose of the investigation, quasi-experimental, was to analyze the impact of creative dance in the learning of Mathematics' concepts in children (7/8 year old) in primary education, in two Portuguese schools. The sample included 8 classes, 117 children in total, of both genders. The intervention has taken place in two groups (experimental group and control group), with four sessions of creative dance in the experimental group. Both groups were assessed on three different occasions (pre-test, post-test and retest). The statistical techniques used for processing the data were the analysis of variance of mixed plans and the Student's *t* test for paired samples. The conclusions showed that the students who consolidated the knowledge in the creative dance classes, exhibited significant differences in their learning gains in Mathematics, as compared to the control group.

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Creative dance; interdisciplinary working; primary education; mathematics

## Education through art

According to Hong (2000), dance literacy in the educational system has two fundamental and complementary purposes: knowledge about dance and knowledge through dance. It is unquestionable that dance, in the educational sphere, should be an artistic and autonomous area, just like other artistic expressions have a central role in integrating the body, artistic, intellectual, creative, and social faculties, promoting a complete and balanced development in children. Notwithstanding, it can also transmit a body of knowledge and values, supported by the instrumentalist perspective – Education through Art. The argument used suggests it as an enhancing tool for different knowledge (Eisner 1997).

Bamford (2009) emphasizes that the intrinsic value of art doesn't mean that one must exclude other educational benefits. There is the conviction that arts, once involving experiences which include the development of skills in different fields, can play a very important

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role in learning, by stimulating and enriching the educational process (Eisner 1997). This perspective is strengthened by Catteral (1998), when the author outlines that, in the four artistic areas (Dance, Music, Theatre and Visual Arts), the cognitive abilities, such as creativity, imagination and critical thought, improve learning in other disciplines. In Rooney's (2004) opinion, literature recommends arts integration in the curriculum, pointing out the effect taken on the level of interest and students' motivation as well as their cognitive abilities with gains in academic performance.

The development of different forms of communication triggered by arts that involve experiencing, creating and feeling/appreciating, promotes a positive relationship between the learning of arts and other disciplines (Zwirn 2005).

## Creative dance and learning – an interdisciplinary methodology applied to mathematics

Dance in education can play an unquestionable role in the child's integral growth, being an essential component in physical (body and movement), emotional and artistic (to think and feel), social (communicate and be with the others), cognitive and creative (learning different ways to express an idea) development.

The literature presents studies that relate the effects of dance in cognitive, motor and social skills, as well as in learning competences in different disciplinary areas (Catteral 2002; Kim 2002; McMahon, Rose, and Parks 2003; Minton 2003a; Morin 2004; Rule, Dockstader & Stewart, 2006; Wang 2004; Gabbei and Clemmens 2005; Giguere 2006; Keun and Hunt 2006; Lobo and Winsler 2006; Almeida 2007; Pennington 2010; Melchior 2011; Rose, 2002).

In regards to dance being a catalyst for learning Mathematics' contents, Wood (2008) considers that learning through doing develops a better understanding of the mathematical content, as well as a greater durability in knowledge retention. The results of the study, where Wood analyzed if dance and movement could be effective in supporting the learning of concepts, suggest that students explored new ideas and discovered new concepts, because they worked within a context that involved movement and body. This idea of learning through doing is strengthened by Rosenfeld (2013), when the author states that this is the aspect in common between Mathematics and dance. With the project 'Math In Your Feet Program', the author linked Percussive dance and Mathematics, so the children could explore and discover new ways of using the mathematical concepts, by building more original and interesting choreographies. The author claims that children also develop and use the skills of mathematical thought through the process of creating and executing dances. Another study intended to analyze the effect of traditional dance in the learning of the symmetry concept, concluding that traditional dances can help students in understanding this concept and reinventing mathematical ideas (Hartono and Helsa 2011).

With creative dance, the child is able to express ideas, thoughts, feelings and concepts through the body and movement, developing the experience of dancing/doing, creating/inventing, observing and feeling through dance (Vitorino 2001). Creative dance could be a means to interdisciplinary learning, by articulating the contents of creative dance with the contents of the disciplinary areas, because it facilitates the materialization of knowledge. The abstract concepts are analyzed through expressive movements, promoting creativity (Hanna 2001). Movement can make learning more efficient and the interactions between movement and the disciplinary contents can improve learning (Lengel and Kuczala 2010).

Just as Minton (2003b) suggests, encompassing the movement in the teaching process (*active learning*) helps students to remember concepts and ideas. Becker (2013) emphasizes this point, by stressing that children will not only have a better understanding, but will also remember the concepts for longer, when the body is involved in the learning process.

Considering the idea that children gain a better understanding of concepts if they have the opportunity to transform it into movement (Minton 2008), we crossed dance and mathematics learning content, establishing connections among subjects and links among contents, to evaluate the creative dance potential in learning mathematical concepts.

## Investigation

One feature of creative dance is that it can be developed based on themes. This led us to embed mathematical concepts as such a theme into dance classes. This study, quasi-experimental, took place in an educational context with the intervention of four sessions of creative dance in the experimental group, given that both groups (experimental and control group) were assessed at three different moments: (1) before the intervention, a measure of pre-test; (2) immediately after the intervention, a measure of post-test (consolidation); and (3) one month after the post-test, a measure of retest (retention).

## Purpose and hypotheses

The purpose of the investigation was to analyze the impact of creative dance on the learning of mathematical concepts in children (7/8 years old) attending the 2nd Grade (primary education) in consolidation and retention valences. Thus, we delineated the following hypotheses:

*H1*: The students who took part in the creative dance classes present significant differences on the learning gains when they consolidate the contents of Mathematics, in comparison with the students that consolidate through the traditional methodology.

*H2*: The students who took part in the creative dance classes keep their learning gains of Mathematics' contents, after a month of intervention, in comparison with the students that consolidate through the traditional methodology.

## Sample

The sample was selected amongst students who attend the second Grade, in primary education, in two Portuguese schools located in Coimbra, in the year 2010/2011. The intervention occurred with 8 classes (initially 166 children in total), 5 of which participated in the experimental group (EG – 102 children) and the other 3 in the control group (CG – 64 children) and from the original sample only 117 children participated in our study. The reason for this difference of subjects was due the three selection criteria, defined for their inclusion in the definite sample: (1) students who were for the first time on the 2nd Grade; (2) students without special educational needs; and (3) students who didn't attend creative dance, classical dance and drama expression classes. These sample (cf. Table 1) was composed of 66 male subjects (56.4%) and 51 female subjects (43.6%).

**Table 1.** Sample distribution according to the group and students' gender.

| | *Gender* | | | | | |
|---|---|---|---|---|---|---|
| | Female | | Male | | *Total* | |
| Group | *n* | % | *n* | % | *N* | % |
| Control | 15 | 12.8 | 31 | 26.5 | 46 | 39.3 |
| Experimental | 36 | 30.8 | 35 | 29.9 | 71 | 60.7 |
| Total | 51 | 43.6 | 66 | 56.4 | 117 | 100.0 |

**Table 2.** Intervention plan.

| | Experimental Group (EG) | Control Group (CG) |
|---|---|---|
| MATHEMATICS | Pre-test | |
| | *Content acquisition phase* (class teacher) | |
| | *Content consolidation phase* | |
| | 4 creative dance sessions (dance teacher) | 4 sessions in the traditional methodology (class teacher) |
| | Pos-test | |
| | *Content retention phase* | |
| | Retest | |

The EG had 71 children (60.7% of the total sample), 35 boys (49.3% of EG) and 36 girls (50.7%). The CG had 46 children (39.3% of the total sample), 31 boys (67.4% of CG) and 15 girls (32.6%).

## Study design

The study was executed between 31st January and 8th April, 2011, in both experimental and control groups. The intervention involved the following procedures: in both groups the class teacher, every week (during the month of February), taught the defined math contents. On the following week, during the classes intended for consolidation of contents, the EG made a revision of the contents through a creative dance class, with a dance teacher and the CG made a revision through a schoolbook worksheet. All students also replied to a test, which has been prepared on the basis of the Mathematics' contents that were set. This test was applied on three moments: before the intervention (pre-test), after the intervention (post-test) and one month after the intervention (retest) (cf. Table 2).

To overcome the ethical problems from the fact that the control group didn't attend the creative dance classes, the students of this group had the same dance classes that the experimental group had, but after this experiment had been concluded.

## Creative dance sessions with mathematics

We developed four creative dance sessions with Mathematics in an interdisciplinary methodology (Gilbert 2002; Overby, Post, and Newman 2005; Neto 2008; Monteiro and Rocha 2010a, 2010b). The Mathematics' contents included two key issues which are described in Table 3.

The creative dance contents are the four elements of movement – Body, Space, Energy (movement qualities) and Relationship, making part of Laban's conceptual frame. We

**Table 3.** Mathematics' contents.

| Themes | |
|---|---|
| Numbers and operations | Quantities and measures |
| Composing and decomposing numbers up to 700, 800, 900, and 1000 | Money: notes, coins, and objects' cost |
| Decimals (relating ones/tens/hundreds/thousands) multiplying by 10 | Measurement of time: time and day (day time/clock hands); month and year (seasons, months/number of days) |
| Regularities in addition and subtraction (addition with three addends) | |

developed exercises of dance, analyzing the similarities between the exercises and the Mathematics' contents and the potential connections between contents, having in mind the equity measure, so each session would encompass the four elements. Thereby, the exercises of dance included, from the element Body, the actions, parts and shapes with the body and from the element Space, the own and/or general space (shareable space) with movement levels, directions, trajectories, and dimensions. They also brought together, from the element Energy, movement qualities like fast/slow, accelerate/decelerate, sudden/sustained, free/bound, strong/light, performed individually, in pairs and in a group, developing the element Relationship.

The classes all used visual (pictures and objects) and auditory (music, clubs and tambourine) stimulating the imagination and creativity. The dance exercises developed in the classes were entitled with the Mathematics' studied content/concepts, e.g. the students performed the 'multiplying by 10 dance', the 'notes and coins dance', the 'clock hands dance', the 'thousands dance', the 'units dance' (relating ones/tens/hundreds/thousands), and the 'three addends dance' (addition).

All lessons were taught during the morning hours, in each class classroom and the lesson plans were assessed by a specialist teacher before the lecture.

The dance classes, lasting 60 min each, adopted the following structure with five parts (Monteiro 2007):

1st part – Theme presentation (5 min): corporal/expressive presentation of each student's name and presentation of the math contents to work with;

2nd part – Warming up related to the theme (10 min): preparing the body for movement and for dance;

3rd part – Creative development of the theme - through the elements of dance (30 min): kinetic, expressive, and creative experimentation of the movement elements interconnected with the mathematics content defined for the session;

4th part – Presentation/analysis of the danced compositions (10 min): presenting and observing the movements created;

5th part – Session conclusion (5 min): remembering the experienced dance contents/exercises and accomplishing an exercise of corporal and expressive exploration with stretching movements.

Dance exercises were developed by exploring the connections between the different elements of movement and the mathematical content/concepts. The children have achieved learning with different body movements that led them to create possible representations of mathematical concepts, and search for different expressive solutions for the proposed problems.

In the second part of the classes, i. e., in the Warming up related to the theme, we maintained the same structure of three exercises that have been built from the mathematical concept of composing and decomposing numbers, with a progression of numbering during the four classes (numbers up to 700, 800, 900, and 1000). In the first exercise, the students represented the numbers (1 to 9) adopting different shapes with their body segments. Afterwards, they imagined that the presented number would move through the classroom area (e.g. number 5), thus, exploring a way of move through the space keeping their body in the shape of a number (cf. Table 4).

In exercise 2, the students have explored different ways of walking and running, having, thereafter, to represent a number through body shapes with their peer (cf. Figure 1), for example, number 24, one student represents the tens digit (number 2) and the other student represents the ones digit (number 4). They would repeat the exercise, but with numbers up to 700 (hundreds), as can be seen in Table 4.

The dance exercises in the third part of the class, i.e. in the Creative development of the theme – through the elements of dance, were centered in the kinetic, expressive, and creative experience of the movement elements interconnected with the Mathematics' contents, developing a concrete and perceptible learning experience of the concepts through the body.

One of the Mathematics concepts studied in the dance class No.1 was the multiplication by 10. In this exercise called 'multiplying by 10 dance', the children have related the number taking the number of steps to represent it, i. e. if the number is 6, they would have to create a movement by repeating it 6 times, following a music pace (Overby et al., 2005b, track 28). Then, they would multiply by 10 through a leap, in which the legs «hold» the zero in the air, as a mean to represent it. Next, the students would maintain that leg position (representing the zero- by standing with feet together and legs apart, with a slight bend in the knees) and with the fingers would show the number. In this example, they raised six fingers, discovering, thereby, a form of movement and dancing through the space representing the 60.

The 'clock hands dance', that occurred in the dance class No. 2, was developed from the concept – measurement of time: time and day (hours of the day[1]/clock hands). This exercise, described in Table 5, was accomplished in peers: one element represented the hour hand and the other the minute hand, and both danced the minutes to reach the hours (cf. Figures 2 and 3).

Another mathematical content was the decimals (relating ones/tens/hundreds/thousands), worked in the dance class No. 3. We present two exercises, called 'thousands dance' and 'units dance', which related the size of the movement with the mathematical content, in this case, the size of the step. Accordingly, one small step represented one unit, one medium step one tens, a big step one hundred, and one very big step with a leap one thousand. (cf. Table 6 and Figure 4).

Another example of an exercise, called 'three addends dance', is related to the addition with three addends concept, which was taught in dance class No. 4.

This exercise was carried out in trios, in which each child represented one proposed addend (for instance, 13 + 11 + 34 = 58) by dancing according to the method explained above, i.e. the relationship between the number and the size of the steps and the music pace (Lóio 2000; track 8). Then, the students who represented the first addend placed the fingers (in this case, one finger of the left hand and three of the right one) on a prefabricated cardboard poster on the floor, which had the representation of an addition with three addends (cf. Figure 5) exploring a still body shape and so on (cf. Figure 6). Each trio

**Table 4.** Warming up according to lesson plan No. 1.

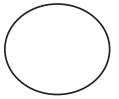
| 2. Warming up related to the theme | | | | |
|---|---|---|---|---|
| 10′ | Partial | Organization | Description | Observations |
| TIME | 4′ | Concentric circle  | 1. Intermediating the mobilization of the different parts of the body (head-feet direction) with body representation of numbers: 1 to 9 (in each body representation of the number, and when the teacher suggests, moves through the space changing place in the circle) | |
| | 3′ | Concentric circle, peers (No. 1/No. 2) 2 1  | 2. Exploring the walk and the run through the space, with the music pace; when the music stops they go back to their starting position in the circle, and with the peer represent number 10 with the body (one is 1 and the other is 0) and form a tens unit; repeat with other numbers: 28, 45, and 3 tens and 6 ones | (Overby, Post, and Newman 2005a, track 40)<br>(peer hand in hand: the element who has the left arm free represents the tens digit and the other the ones digit)<br>Cardboards on the floor for each peer<br>T O |
| | 3′ | Concentric circle, trios 3 2 1  | 2.1. The same, body representation of 500, 250, 3 hundreds and 450 | Cardboards on the floor for each trio<br>H T O |

**Figure 1.** Representation of number 24 (body shapes).

**Table 5.** Dance exercise according to lesson plan No. 2.

| | | | 3. Creative development of the theme - through the elements of dance | |
|---|---|---|---|---|
| 30′ | Partial | Organization | Description | Observations |
| TIME | 3′ | Concentric circle peers (No. 1 front/ No. 2 back) | *5. Clock hands dance*<br>5.1. The Nos.1 start by exploring a way of displacement, with a slow movement time, to represent bodily the small clock hand (hours) (closed position, at the lower level); when they hear the sound of the tambourine, they go back to their position in the circle and the Nos. 2 start to represent bodily the minute hand (medium level position), moving around one step at a time; repeat | Laying the cardboards on the floor – each with the watch face draw (Goude 1996, track 7) tambourine |
| | 5′ | | 5.2. Each peer place oneself on the watch face drawn on the cardboard and move to 12 o'clock (No. 1- small hand/No. 2- big hand); then they hear 60 fast tambourine beats, and No.2 has to make the 'big hand course', a circle around No.1, who, in the meantime moves very slowly from 12 to 1 in the face watch. The teacher says it's 1 o'clock P.M.<br>They repeat the same procedure to 4 o'clock P.M., changing roles to perform 9 o'clock to 11 o'clock P.M.; 2 o'clock to 6 o'clock A.M. (…) | |

reached the result, by sliding their hands at the same time to the place where the result was (the last part of representation), counting the fingers (in this example, 5 fingers in the tens column and 8 fingers in the ones column). In the end, the trios showed, with the music, the addition's result. In this example, the trio, lined up, takes 5 medium steps and 8 small steps (because the result of the addition is 58). At the same time, each student has the fingers raised according to the addend that he/she represented. In other words, the first student in line is the first addend (number 13), showing 1 finger of the left hand and 3 fingers of the right hand; the second one raises 1 finger of each hand (number 11); and the third raises 3 fingers of the left hand and 4 fingers of the right hand (number 34).

**Figure 2.** Representing the clock hands (body shapes).

**Figure 3.** 'Clock hands dance'.

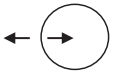
## Results

We present the descriptive analysis of all the students regarding the performance in the disciplinary area of study. We proceed with the results of inferential statistics, analyzing the academic performance related with the use of creative dance in the learning process of Mathematics' contents, during the three moments of data acquisition (pre, post and retest), of the CG and EG groups.

Data concerning the minimum (*Min*) and maximum (*Max*) values, the average score (*M*), the standard deviation (S*D*) and the standard error (S*E*) of the total sample in the three moments of data acquisition are presented in Table 7.

Considering the measures of central tendency, we note that the obtained values stay between 55.10% and 79.09%, which leads us to the conclusion that, generally speaking, the respondent students show positive results. The lowest minimum value lies at 5.75%, while the highest corresponds to the maximum of the scale (100.0%). The results reveal

**Table 6.** Dance exercises according to lesson plan No. 3.

| 3. Creative development of the theme - through the elements of dance | | | | |
|---|---|---|---|---|
| 30′ | Partial | Organization | Description | Observations |
| TIME | 5′ | | (…)<br>*6. Thousands dance* | |
| | | Concentric circle (No. 1 for circle centre, No. 2 eccentric circle – peers back to back)<br>  | After reading and listening to the number – four hundred and fifty-two (452), the students perform the dance composing*: 4 big steps, 5 mediums and two small; afterwards they represent the numbers with the fingers (except «0», which is represented with the whole body), exploring the movements like leaping, sliding or galloping until return to the position in the circle. Finally, they write the number on the floor;<br>They repeat with nine hundred and thirty-seven (937), one thousand (1000). | Tambourine<br>The number is written out on the board<br>452<br>937<br>1000 |
| | 5′ | Concentric circle, peers (No. 1 ahead, No. 2 behind) | *7. Units dance*<br>The Nos.1 of each pair perform the movements with the music pace (large/small movements) and the Nos.2 copy as if they were the shadow, without leaving their place; when the music stops, they 'freeze' and the Nos.1 move around* until they find a number that has a three in the tens unit - 334 or 430 or 533 or 732; repeats with the following units, exchanging roles:<br>5 in the hundreds unit<br>7 in the ones unit<br>1 in the thousands unit<br>(…) | (Corea 1984, track 10)<br>Cardboards on the floor, in the centre of the circle, with numbers<br><br>430; 334 732; 940; 581; 509; 533; 562; 987; 857; 707; 167; 1000 (3x)<br><br>*ones- small steps<br>tens- medium steps<br>hundreds- big steps<br>thousands- very big step with leap |

(a) Shadow (b) Freeze

Figure 4. 'Units dance'.

| Tens | Ones |
|---|---|
| . | . |
| . | . |
| . | . |
| | |

Figure 5. Graphic representation of an addition with three addends.

Figure 6. 'Three addends dance'.

an increase from the pre-test to the post-test and from the post-test to the retest. The Student's *t* tests for paired samples showed significant differences between the post-test and the pre-test, $t\,(107) = -5.99$, $p < .001$, as well as between the post-test and the retest, $t\,(107) = -7.05$, $p < .001$.

Data concerning the classification in Mathematics, of the total sample, for the three moments (pre-test, post-test and retest) are presented in Figure 7.

To test our hypothesis H1, we performed analysis of variance, adopting as independent variable the intervention process used for knowledge consolidation (through dance - EG, or through the traditional method -CG) and as dependent variables (DVs) the classifications of academic performance in Mathematics in three different moments (pre-test, post-test and retest). The experimental design can be traduced by a 2 Intervention Process (Dance vs Traditional) × 3 moment of acquisition (pre, pos, retest) analysis. We tested the academic performance in three different moments to evaluate, on the basis of this longitudinal information, the evolutionary path of the students in order to find which of the two groups (EG and CG) had the greater progress. For that purpose, we performed analysis of variance of mixed plans, taking as a factor of repeated measures (intra-subjects) the classifications of Mathematics in the three moments and the intervention process (Dance vs

**Table 7.** Minimum and maximum values, average score, standard deviation and standard error, from the Mathematics tests in the three moments of data collection.

| Mathematics tests | Min | Max | M | SD | SE |
|---|---|---|---|---|---|
| Pre-test | 5.75 | 100.00 | 55.10 | 20.37 | 1.88 |
| Post-test | 16.20 | 100.00 | 67.51 | 20.07 | 1.86 |
| Retest | 23.50 | 100.00 | 79.09 | 14.90 | 1.38 |

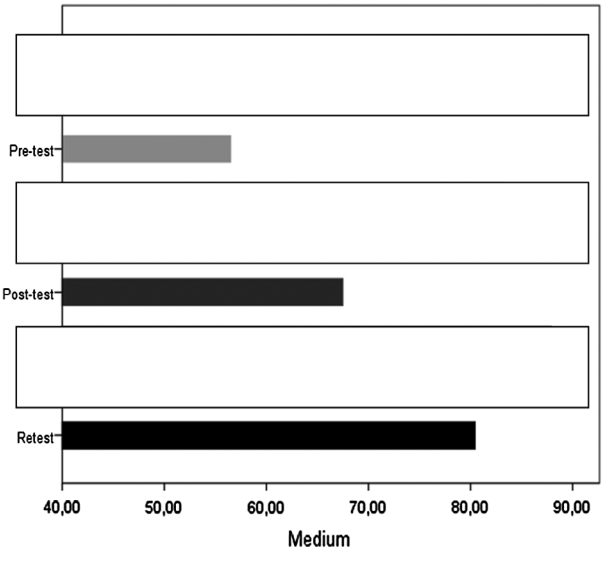



**Figure 7.** Average score of the results in Mathematics for the three moments of evaluation: pre-test, post-test and retest.

**Table 8.** Average score and standard deviation of the classifications in Mathematics in the pre-test, post-test and retest depending on the consolidation of learning through the traditional method (CG) and through dance (EG).

| | *Consolidation of learning* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-test | | | | Post-test | | | | Retest | | | |
| | Traditional (CG) | | Dance (EG) | | Traditional (CG) | | Dance (EG) | | Traditional (CG) | | Dance (EG) | |
| | (*n* = 46) | | (*n* = 71) | | (*n* = 46) | | (*n* = 71) | | (*n* = 46) | | (*n* = 71) | |
| *Academic performance* | *M* | *DP* | *M* | *DP* | *M* | *DP* | *M* | *DP* | *M* | *DP* | *M* | *DP* |
| Mathematics | 61.00 | 21.49 | 51.28 | 18.79 | 60.72 | 20.20 | 71.91 | 18.86 | 78.58 | 15.56 | 79.42 | 14.55 |

Traditional) as inter-subjects factor. The mixed plan pointed out for a significant effect for the intra-subjects factor, $\Lambda$ de Wilks = 0.323, $F\,(2, 202) = 92.01$, $p < .001$, $\eta^2 = .477$, as well as an interaction of the intra-subjects factor with the inter-subjects factor, $F\,(2, 202) = 20.45$, $p < .001$, $\eta^2 = .168$. Given the statistical significance of the interaction, the main effect of the intervention process didn't prove to be statistically significant, $F\,(1, 115) = 0.07$, $p = .789$, $\eta^2 = .001$. Relegating the main effect of the group to a secondary position and focusing on the interaction between the two kinds of variables analyzed in this mixed plan (cf. Table 8), it can be seen that students of the EG showed significantly lower results in the pre-test than the students of the CG, exceeding them in the post-test and keeping the same difference in the retest, suggesting a positive effect of the consolidation through dance.

The Figure 8 is, in what regards this matter, enlightening about the academic path made by both groups.

To reinforce H1 results and test H2, we analyze now the differences between the classifications from the pre-test to the post-test and from the post-test to the retest, in both groups (EG and CG). The results from the Student's *t* tests for paired samples, considering the three moments of evaluation and, specifically, comparing the differences of performance from the pre-test to the post-test and from the post-test to the retest in each group are presented in Table 9.

It can be observed, a significant improvement from the pre-test to the post-test, for EG students. ($p < .001$). *Thus, the students from the EG show a great improvement after the consolidation of the contents of Mathematics through dance. Dance seems to be more favorable compared to the traditional method, in what concerns Mathematics knowledge consolidation.*

The H2 testing was made through the comparison of the post-test and retest performances, enlightening us about the stability of knowledge acquisition (retention) (cf. Table 9). The inspection of the results of Student's *t* test for paired samples allows us to note that the EG maintained its best performance, maintaining the difference acquired in the post-test stage, by comparison with CG (cf. average score in Table 8 and Figure 8). Therefore, *consolidation through dance seems to have contributed to stabilize the retention of knowledge, one month after the learning of contents, leading us to determine that the method through dance is favorable to the stability of knowledge acquisition* (cf. paired differences of the post-test related to the retest in Table 9). However, the CG showed an increase of the results, but didn't achieve the results of the EG. Nevertheless, we remind that the results of the CG in the post-test were lower than the results of the EG (cf. average score in Table 8), with a greater growth, by comparison to the EG from the post-test to the retest.

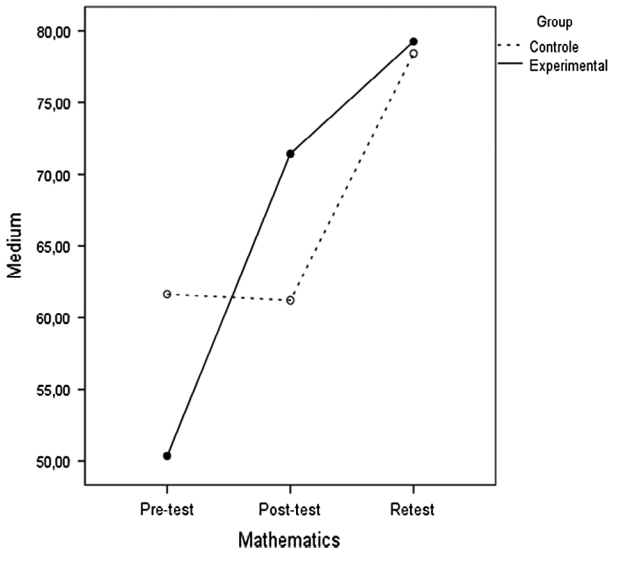



**Figure 8.** Mathematics' classifications in the pre-test, post-test and retest depending on the consolidation of learning through the traditional method (CG) and through dance (EG): average score.

**Table 9.** Comparison of the average score of the classifications in Mathematics in the pre-test, post-test, and retest, depending on consolidation of learning through the traditional method (CG) and through dance (EG): paired differences.

| | *Consolidation of learning* | | | | | | |
|---|---|---|---|---|---|---|---|
| | Traditional (CG) ($n$ = 46) | | | Dance (EG) ($n$ = 71) | | | |
| | *Paired differences* | | | *Paired differences* | | | |
| *Classifications* | Average | Standard deviation | $t$ (45) | Average | Standard deviation | $t$ (70) | *Hypotheses Testing* |
| Mathematics (*Pairs to compare)* | | | | | | | |
| Pre-test – Post-test | 0.27 | 22.11 | 0.08 | −20.63 | 16.54 | −10.51*** | H1 |
| Post-test – Retest | −17.85 | 18.34 | −6.60*** | −7.51 | 14.99 | −4.22*** | H2 |

***$p < .001$.

In light of the above, we conclude that the observed results support the hypotheses that had been formulated.

## Conclusion

The results of the study, globally, showed that students, who consolidated the contents in the creative dance classes, by comparison to the control group who followed a more traditional method of intervention, presented significant differences in the learning gains in Mathematics. It is quite clear the consolidation of knowledge in the EG, from the pre-test to the post-test and the maintaining of the results, (with a slight improvement), from the post-test to the retest. So, we observed a positive impact of creative dance on the consolidation of Mathematics' contents.

It seems, therefore, to be confirmed that if creative dance connects with Mathematics, it will enhance, as the results of the study have shown, the child's ability to explore/assimilate abstract concepts from concrete situations through the movement and the body, allowing the achievement of better results during the learning process. This idea of using body awareness in the learning process is emphasized by Griss (1998): '(…) «Teach from the known to the unknown», you will understand the value of allowing children to learn from their bodies' (p.14).

According to our literature review, this investigation, forming part of the study carried out in the doctoral thesis, concluded in 2015, has a pioneering character because of the objectivity of the intervention methodology we developed and the data handling carried out. Thus, it would be interesting to analyse the influence of some socio-demographic characteristics (gender, for instance) on strengthening apprenticeship through dance. There will be also benefits in replicating the study with other samples, for example in other educational levels, with other Mathematics' contents or with longer interventions, in order to reinforce the potential of dance in an interdisciplinary methodology, highlighting the positive effect of creative dance in the learning of the Mathematics' contents, which is proved by the results of the study.

## Note

1. The hourly system adopted in Portugal is the 24-h system. The division of the day in two periods corresponds to:
   - AM ('before noon') is the period starting at midnight (00:00) and ending at 11:59.
   - PM ('after noon') is the period starting at noon (12:00) and ending at 23:59.

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No potential conflict of interest was reported by the authors.

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