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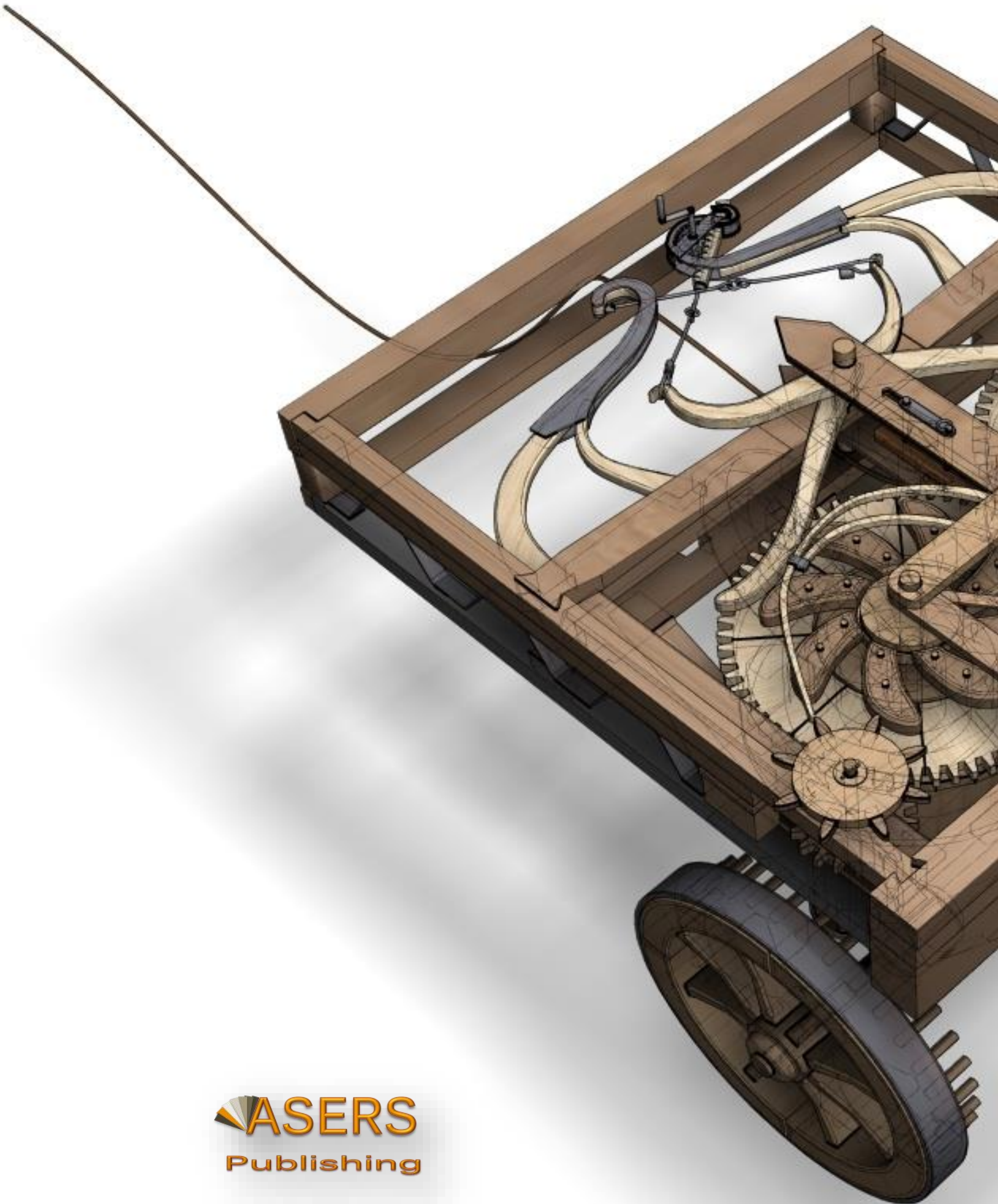

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Volume XV, Issue 17, 2023
Journal of Research in Educational Sciences

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Teachers' Perceived Impacts of Finger-Counting Manipulative as Basis for a Solid Foundation in Mathematics in Nigeria

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Abstract: *This paper was designed to determine preschool, primary school teachers, and secondary school Mathematics teachers' and special educators' views of finger-counting as the basis for a solid foundation in learning Mathematics. One hundred Participants were selected using purposive sampling. One research question and three hypotheses were raised to guide the study. The adapted instrument from Mutlu et al. (2020) titled the finger-counting questionnaire with a reliability index of 0.78 was used to gather data for the study. Data collected were analyzed using percentage, mean, t-test, and ANOVA statistics. The results showed that teachers perceived impacts of finger-counting that; it facilitates learning by touching, turns abstract into concrete resulting in meaningful learning, makes counting practical and accessible, facilitates retention and internalization, increases numerical, arithmetic, and problem-solving skills, and also improves attitudes towards mathematics. Findings also revealed no differences exist among teachers on the perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on their gender and teachers' category but significant differences exist in their years of teaching experience. In conclusion, finger counting should not be seen as an alternative or optional but as an indispensable tool in teaching and learning Mathematics. The researchers recommended that because people abandon finger-counting strategies once they develop cognitive and affective skills, finger-counting should be seen as a transition process rather than an obstacle to the development of mental arithmetic skills.*

Keywords: finger-counting; education; manipulative; mathematics.

JEL Classification: I20; I29.

Introduction

Manipulatives can be understood as objects that can be moved, and handled and facilitate learners' understanding of the mathematical situation (Gifford, Back, and Griffiths 2015, 1). Manipulatives promote the understanding and internalization of concepts in Mathematics and the accomplishment of arithmetic operational steps. Manipulatives vary from one mathematical concept to another. Examples of manipulatives are marbles, beads, pattern blocks, buttons, matchsticks, base blocks, decimals beans, and fingers (Sternberg and Grigorenko 2004; Mink 2010). According to Mutlu, Akgünand Akkuşci (2020), fingers are concrete manipulative, and component of our body. The hand is considered the first calculating and counting machine of all ages (Ifrah 1985 cited in Mutlu 2019). Fingers are recognized as the most natural tool for counting because it is universally accessible, nimble, and possess discrete quantity (Andres *et al.* 2008; Di Luca and Parenti 2011; Bender and Beller 2011).

Research has shown that finger-counting has close neural connections in the brain; it has generated much attention and turned to be the subject of studies in areas like educational psychology, educational neuroscience, and education in recent years (Mutlu, Akgün and Akkuşci 2020). Before children acquire expertise in speech production, they have used their fingers to intimate, notify and convey mathematical and numerical concepts. (Berteletti and Booth 2015; Lee, Kotsopoulos, Tumber, and Makosz 2014). Many primary school teachers report that children seem to use fingers intuitively for counting and computation (Segemann and Grunke 2014). Many experimental studies have confirmed the positive impact of finger-counting manipulatives in teaching and learning Mathematics. The work of Gracia-Bafalluy and Noel (2008) has shown that finger counting manipulative improves Mathematics performance. Moeller *et al.* (2011) state that finger-counting enhance children's potential to make use of symbol and develop their mathematical skills. Also, Wasner *et al.* (2015) reveal that finger-counting is efficient in teaching number order, quantity, one-to-one counting, and cardinal numbers while Stegeman and Grunke (2014) report that finger-counting encourages the attitude of students toward learning Mathematics. Guha (2006) reports from teachers' perspective finger-counting is a productive device for numbering and calculating. The negative impacts of finger-counting have prompted some researchers to carry out studies to discourage students from using it. Albayrak (2010) reveals that students learn better in basic arithmetic when being taught with concrete objects than fingers.

Culturally speaking, human beings oftentimes make use of their fingers and whole body to symbolize numbers (Berteletti and Booth 2015). Using fingers to count can be seen as one of the first techniques used to connect verbal representation with its numerical meaning (Berteletti and Booth 2015; Butterworth, 1999). Notwithstanding, a dichotomy exists from culture to culture in representing numerical concepts with fingers (Mutlu, Akgün and Akkuşci 2020; Pika, Nicolas and Marentette 2009; Bender and Beller 2012) to the extent that the numerical quantity conveyed may be reconstructed by 1-1 counting in the non-existence of language (Berteletti and Booth 2015). Studies have shown that hand and finger representation have an impact on children and adults at different stages of numerical processing (Badets, Pesenti, and Olivier 2010; Badets and Pesenti 2010; Berteletti 2015; Di Luca and Pesenti 2008).

Studies have shown that hand compositions are naturally linked with mathematical illustration even among adults (Badets and Pesenti 2010; Badets, Pesenti, and Olivier 2010; Di Luca, Granà, Semenza, Seron, and Pesenti 2006; Di Luca and Pesenti 2008). Studies have also shown that dyscalculia children depend more on fingers when set side by side with their counterparts either to speed up the accomplishment of action-specific processes (Alibali and DiRusso 1999; Geary 2005). Research conducted by Barrouillet and Lépine (2005) and Brrouillet *et al.* (2008) opined that in a situation when calculation and counting methods are not automatic, finger-counting relieves brain memory and essential visual images. Finger-counting techniques have an impact on numerical illustration (Newman and Soylu 2013; Klein *et al.* 2011; Badets *et al.* 2010). Training children training on finger discrimination assignments improve their numerical accomplishment (Sinclair and Pimm 2015; Gracia-Bafalluy and Noël 2008). Over 20 years of research suggest that foundational Mathematics skills are the building blocks for tomorrow's success and also a strong predictor of literacy skills (Duncan *et al.* 2007). A breakdown of six longitudinal studies showed that early Mathematics skills possess the greatest prognostic power of future achievement, accompanied by reading and then attention skills (Duncan *et al.* 2007). Berteletti and Booth (2015) revealed that the finger motor part of the brain triggers more intensely for subtraction than multiplication. This was also supported by Michaux *et al.* (2013) who remarked that finger-counting meddles more with subtraction and addition and is indifferent to problems involving multiplication

Combine evidence of dyscalculia as an apparent deficit comes from studies of impairments in the mental and neural representation of fingers. Many years of research have shown that fingers are used in attaining arithmetical competence. This requires understanding the graph between the set of fingers and the set of objects to be itemized. If the mental representation of fingers is weak, or if there is a deficit in understanding the manifold of sets, as a result, the child's cognitive development may fail to form the link between fingers and the manifold of sets.

Developmental weakness in finger representation ('finger agnosia') is a predictor of arithmetical ability (Noël 2005). Gerstmann's Syndrome, whose symptoms include finger agnosia and dyscalculia, is due to an abnormality in the parietal lobe and, in its developmental form, is also associated with poor arithmetical attainment (Butterworth *et al.* 2011).

Most previous research on finger counting as we have mentioned above did not seek the opinion of teachers on the impact of finger counting on pupils learning Mathematics which is one of the gaps this study intends to fill. Moreover, to the best knowledge of the researchers, this study may be the first in Nigeria to look at the differences in the male and female teachers' perceived impacts of finger counting in teaching and learning Mathematics. Likewise, no study from the literature consulted and reported in this study has examined whether the category of school teachers belong to has an impact on their perceived impact of finger counting in teaching and learning Mathematics.

Statement of the Problem

Children from kindergarten typically learn basic arithmetic and numerical principles through finger-counting manipulatives. However, whether or not dependence on finger-counting manipulatives is beneficial or detrimental is the subject of debate among researchers. Up to the present time, little is known regarding the impact of finger-counting manipulatives in creating and forming a strong numerical and arithmetical understanding. Undoubtedly, more insight into the impacts brought about through the use of finger-counting manipulatives will help accomplish better educational practices and probably produce substitute means to cure difficulties encountered in learning Mathematics.

Research Question

1. What are the preschool, primary, special educators, and Mathematics teachers' perceived impacts of finger-counting as the basis for laying a solid foundation in teaching and learning Mathematics?

Hypotheses

HO_1: There is no significant difference in teachers' perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on gender.
HO_2: There is no teachers' perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics on the category of teachers.
HO_3: There is no teacher's perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on their years of teaching experience.

1. Methodology

The study employed a descriptive survey design. The population for the study consists of preschool, primary, and special educators and Mathematics teachers in secondary schools in Lafia Local governments of Nasarawa State. 42 (42%) were males, and 57 (57%) were female respondents. Preschool teachers were 17 (17%), Primary school teachers were 45(45%), Special educators were 26 (26%) and Mathematics Teachers in secondary school that participated in the study were 12 (12%). Among the participants were 44 (44%) teachers with 1-5 years of teaching experience, 39 (39%) teachers have 6-10 years of teaching experience, 14(14%) teachers have 11-15 years of teaching experience, and lastly 3 (3%) teachers have 16-20 years of teaching experience. The researchers adopted a purposive sampling procedure to choose 100 members of the study population which were considered to make use of the traits being studied when teaching Mathematics. An adapted instrument from Mutlu *et al.* (2020) titled the finger-counting questionnaire with a reliability index of 0.78 was used to gather data for the study. The reliability was determined by administering the questionnaire to 30 mathematics teachers in another local government of the state. The instrument was validated by three mathematics expectations of the Federal University of Lafia. The questionnaire comprised two sections A and B. Section A includes the demographic variables of the respondents such as gender, category of teachers, and years of teaching experience while section B contains 21 items. The items were measured on a four-point Likert scale ranging from strongly agree -4, agree -3, disagree -2, and strongly disagree -1. Data collected were analyzed using percentage, mean, t-test, and ANOVA statistics.

2. Results

Research question 1: What is the preschool, primary, secondary school, and special education teachers' perceived impacts of finger-counting as the basis for a solid foundation in learning Mathematics?

Table 1. Percentage and mean score of items on teachers' perceived impact of finger counting in learning Mathematics.

S/N	Items	SA %	A %	D %	SD %	Mean	Rank
1	Fingers enhance memory and understanding and allow physical interaction with numbers	70 70.0	29 29.0	0	1 1.0	3.68	1st
2	Finger-counting education improves mathematics performance	62 62.0	35 35.0	3 3.0	0	3.59	2nd
3	Increases numerical, arithmetic, and problem-solving skills and also improves attitudes toward mathematics	46 46.0	47 47.0	6 6.0	1 1.0	3.38	9th
4	It facilitates learning by touching.	49 49.0	44 44.0	4 4.0	3 3.0	3.39	6th
5	It turns the abstract into the concrete resulting in meaningful learning	56 56.0	39 39.0	5 5.0	0	3.51	5th
6	It is a tool that students always have with them when they need it.	58 58.0	41 41.0	1 1.0	0	3.57	3rd
7	It makes counting practical.	55 55.0	45 45.0	0	0	3.55	4th
8	I think it is more permanent	45 45.0	47 47.0	7 7.0	1 1.0	3.38	9th
9	Finger-counting enhances retention	40 40.0	55 55.0	4 4.0	1 1.0	3.34	11th
10	Finger-based representations improve children's ability to use symbolic figures and develop their numerical skills	44 44.0	53 53.0	3 3.0	0	3.41	7th
11	They can internalize a subject more easily as they use their own body when they learn it	42 42.0	57 57.0	1 1.0	0	3.41	7th
12	As students become older, they use finger-counting more than doing arithmetic mentally because they find the former easier	34 34.0	44 44.0	19 19.0	3 3.0	3.09	20th
13	I insist that my students use finger-counting instead of getting them to abandon using it.	34 34.0	55 55.0	7 7.0	4 4.0	3.19	18th
14	A limited number of fingers negatively affects calculations	40 40.0	45 45.0	13 13.0	2 2.0	3.23	17th
15	They have a hard time using finger counting and adapting to a new method as the number of steps increases and as multiplication and division problems become more complicated.	34 34.0	55 55.0	7 7.0	4 4.0	3.19	18th
16	I receive parental support to get students to do arithmetic with finger counting at home and at school often	30 30.0	43 43.0	22 22.0	5 5.0	2.98	21st
17	It is limited in terms of calculation	46 46.0	45 45.0	6 6.0	3 3.0	3.34	12th
18	Finger-counting turns into a habit	43 43.0	45 45.0	9 9.0	3 3.0	3.28	16th
19	Pupils/Students should prefer to do arithmetic mentally; otherwise, they need concrete examples in every mathematical operation they have to perform.	45 45.0	45 45.0	7 7.0	3 3.0	3.32	13th
20	Fingers, when properly used, are a natural and already existing toolkit for modeling and reflecting digital information.	38 38.0	58 58.0	2 2.0	2 2.0	3.32	13th
21	If finger-counting is excessively used, pupils/students become dependent on it as it prevents them from doing arithmetic fast.	43 43.0	47 47.0	8 8.0	2 2.0	3.31	15th

To answer this research question, responses of the teachers to 21 items in the questionnaire that addressed teachers' perceived impact of finger counting were collated. The response options (SD = 1, D = 2, A = 3, and SA = 4) were added together and divided by 4 to arrive at the cut-off scores of 2.5. Any item scored below the cut-off marks was considered to have no impact and those items above the cut-off mark were considered as teachers' perceived impact of finger counting in learning Mathematics. Teachers' responses to the items can be seen in Table 1.

From Table 1, it can be seen that all the items scored above the average mean of 2.5. This implies that all the items are teachers' perceived impact of finger counting in learning Mathematics. Item 1 has the highest mean of 3.68 that fingers enhance memory and understanding and allow physical interaction with numbers, Followed by item 2 with mean=3.59 where 97% of the teachers agreed that finger-counting education improves mathematics performance. Ranking third was item 6 with mean =3.57 that which is a tool students always have with them when they need it. Item 5 in the fifth position has a mean = 3.55 that turns abstract into concrete resulting in meaningful learning. Items 4 came sixth while items 10 and 11 share the seventh position respectively. At the bottom of the ranking were items 14, 13, 15, 12, and 16 have positions 17th, 18th, 18th, 20^{th,} and 21st respectively.

Testing Research Hypotheses

Hypothesis 1: There is no significant difference among preschool, Primary school, Mathematics Teachers, and Special Educators on the perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on gender.

To test this hypothesis t-test was employed and the result can be found in Table 2.

Table 2. T-test result on teachers' perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on their gender

Gender	N	Mean	Std.	df	t	Sig.
Male	43	70.98	5.083	98	.832	.401
Female	57	70.05	5.786			
Total	100					

From Table 2, since t = .832 and p > .05, hence the null hypothesis is accepted. This implies that there is no significant difference among preschool, Primary school, Mathematics Teachers, and Special Educators on the perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on gender.

Hypothesis 2: There is no significant difference in teachers' perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on the category of teachers.

There are four categories of teachers in this study. They are preschool, Primary school, Mathematics Teachers, and Special Educators

To test this hypothesis, one-way ANOVA was employed and the results are seen in Table 3

Table 3. One-way ANOVA results on teachers' perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on the category of teachers.

Source of Variance	Sum of Squares	Mean Square	df	F	Sig.
Between Groups	50.797	16.932	3	.555	.646
Within Groups	2929.953	30.520	96		
Total	2980.750		99		

From Table 3, since F(3, 96) = .555 and p=.646 at .05level of significance, hence the null hypothesis is accepted. This implies that there is no significant difference among preschool, Primary school, Special Educators, and Mathematics Teachers on the perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on the category of teachers.

Table 4. One-way ANOVA results on teachers' perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on their years of teaching experience.

Source of Variance	Sum of Squares	Mean Square	df	F	Sig.
Between Groups	287.181	95.727	3	3.412	.021
Within Groups	2693.569	28.058	96		
Total	2980.750		99		

Hypothesis 3: There is no significant difference in teachers' perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics based on their years of teaching experience.

Table 4 shows a significant difference exists in teachers' perceived impact of finger-counting as a basis for a solid foundation in learning Mathematics based on their years of teaching experience since F(3, 96) =3.412 and p = .021, at .05 level of significance. Hence, the null hypothesis is rejected. Tukey HSD test was conducted to determine the direction of significance. The results are presented in Table 5.

Table 5. Tukey HSD to determine the direction of significance

(I) YoTE	(J) YoTE	Mean Difference (I-J)	Std. Error	Sig.	95% CI Lower Bound	95% CI Upper Bound
11-15 years	1-5	-3.295	1.625	.185	-7.55	.95
	6-10	-1.821	1.650	.688	-.614	2.49
	16-20	-9.667*	3.370	.026	-18.48	-.86
16-20 years	1-5	6.371	3.161	.189	-1.89	14.64
	6-10	7.846	3.174	.071	-.45	16.14
	11-15	9.667*	3.370	.026	.86	18.48

* The main difference is significant at the 0.05 level.

Table 5 shows that a significant difference only exists between the teachers with 11-15 years of teaching experience and their counterparts with 16-20 years. However, the mean values for the two groups show that teachers with 16-20 years (Mean= 77.7, SD=1.5) perceived finger counting for a solid foundation in learning Mathematics as having more impact than their counterparts with 11-15 years (Mean= 68.0 SD= 6.4).

3. Discussion

Based on the participants' perception, the impacts of finger counting are that fingers enhance memory and understanding and allow physical interaction with numbers, finger counting education improves mathematics education, increases numerical, arithmetic, and problem-solving, they can internalize a subject more easily as they use their own body when they learn it, it facilitates learning by touching. This supports the findings of Mutlu *et al.* (2020) and Bender and Beller (2012) state that finger representations support the internalization of numerical knowledge. The participants also perceived that finger-based representations improve children's ability to use symbolic figures and develop their numerical skills, finger-counting enhances retention. The findings corroborate that of Andres *et al.* 2008; Glenberg *et al.* 2004; Gracia-Bafalluy and Noel 2007; Mutlu, *et al.* 2020). They observed that fingers are much more effective, practical accessible, and concrete tools and help improve Mathematical skills.

On the other hand, teachers perceived that if finger-counting is excessively used and pupils/students become dependent on it as it prevents them from doing arithmetic fast, It is limited in terms of calculation. This also supports the findings of Mutlu *et al.* 2020. The impacts of finger counting have led some researchers to conduct studies on encouraging students to abandon it. For example, Albayrak (2010) cited in Mutlu *et al.* (2020) thinks that concrete objects be used to discourage students to use finger counting. A study conducted by Mutlu *et al.* (2020) reported that preschool and special education teachers emphasize the positive rather than the negative. This corroborated the findings of this study, teachers perceived that the positive impact of finger counting outweighs the negative.

The researchers went further to find out how teachers perceived the impact of finger-counting as the basis for a solid foundation in learning Mathematics based on their gender, categories of teachers, and years of teaching experience. The findings revealed that no significant difference exists based on teachers' gender. This implies that both male and female teachers perceived the impact the same. This finding corroborated the finding of Akinboboye**,** Ayanwale, and Akande (2021) who found that gender has no impact on the responses of pre-service teachers to the life satisfaction scale. Moreover, examining the impact of finger-counting on pupils/students learning Mathematics also shows no significant difference among the preschool, primary, special educators, and Mathematics teachers. This means that the category of school they belong to has nothing to do with the way they perceived the impact of finger-counting as a basis for a solid foundation. However, the results show that a significant difference only exists between the teachers with 11-15 years of teaching experience and their counterparts with 16-20 years. However, the mean values for the two groups show that teachers with 16-20 years perceived finger counting as a solid foundation in learning Mathematics as having more impact than their counterparts with 11-15 years. This is in line with Nyagah and Gathumbi, (2017) findings in a cross-sectional survey in Kenya. They observed that more experienced teachers are likely to enhance students' academic performance compared to their middle age and younger teachers who sometimes make mistakes.

Successful Mathematics users have well-developed finger representations in their brains that they use into adulthood. Boaler *et al.* (2004) in their submission observed that when we stop pupils/students from using fingers we stop an important part of their mathematical development. Teachers who have stopped pupils from using fingers are doing what they thought was best for children, as the idea that finger use is babyish, and the need to be discouraged is widespread. But we now have the knowledge that should change this and encourage teachers to focus on finger discrimination and use in classrooms to a much greater extent (Boaler *et al.* 2004).

Conclusion

Teachers must organize teaching and learning environments that promote the working memory of the pupils/students and are more appropriate to develop finger counting strategies and teach Mathematics than to ask them to abandon finger counting. Finger counting should not be seen as an alternative or optional but as an indispensable tool in teaching and learning Mathematics.

Recommendations

Based on the findings of this study, the researchers recommend that because of the transparent representation of numerical quantities in finger-counting, teachers can employ fingers as instruments to assist in the learning of numbers.

Because people abandon finger-counting strategies once they develop cognitive and affective skills, finger-counting should be seen as a transition process rather than an obstacle to the development of mental arithmetic skills.

Conflict of Interest Statement

The authors declare no conflict of interest.

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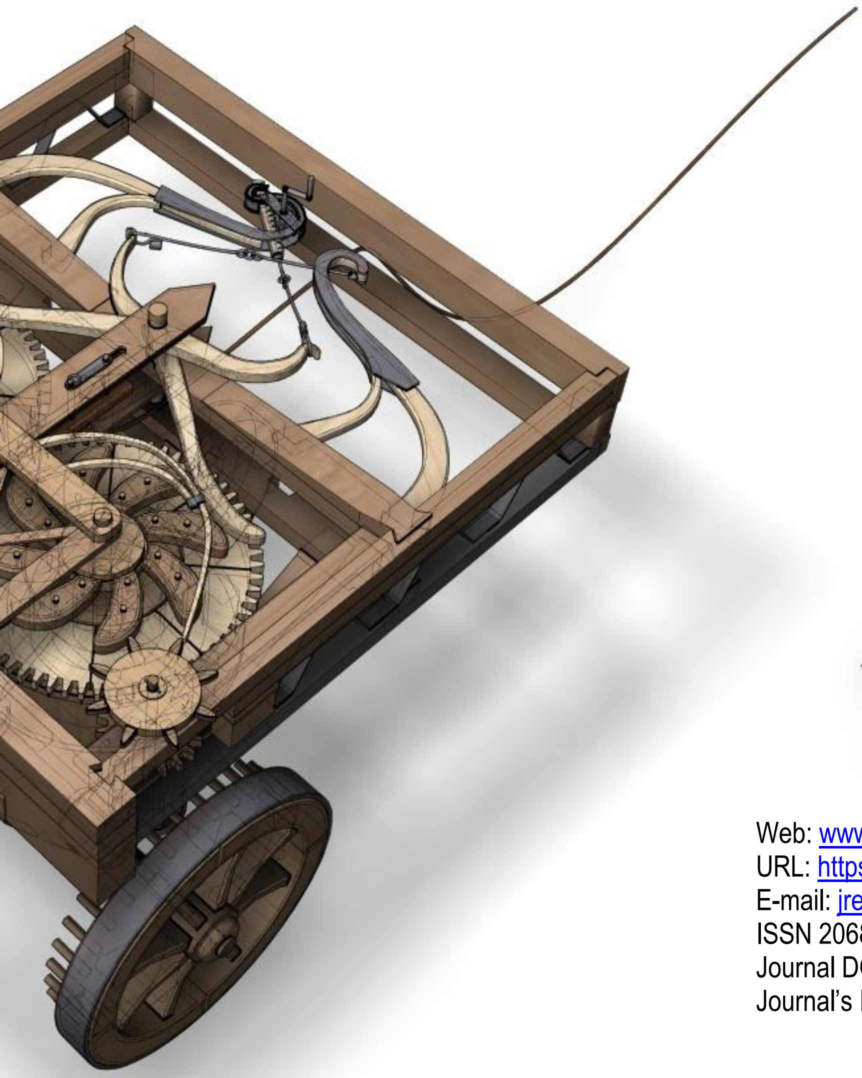

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