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

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**ABSTRACT**

This paper sought to determine preschool, primary, 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 instrument used was adapted from Mutlu and titled the finger-counting questionnaire. It had a reliability index of 0.78. The descriptive survey design was employed. Data collected were analyzed using percentages, means, t-tests, and ANOVA statistics. The results showed that teachers perceived the influence of finger-counting to include the following: facilitating learning by touching, turning abstract into concrete thereby resulting in meaningful learning, making counting practical and accessible, facilitating retention and internalization, increasing numerical, arithmetic, and problem-solving skills, and improving attitudes toward mathematics. Findings also revealed that 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 category. In conclusion, finger counting should be seen 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

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## Introduction

Manipulatives can be understood as objects that can be moved and handled and facilitate learners' understanding of the mathematical situation (Gifford, Back, & Griffiths, 2015, p.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 & Grigorenko, 2004; Mink, 2009). According to Mutlu, Akgün, and Akkuşci (2020), fingers are concrete manipulative, and a component of our body. The hand is considered the first calculating and counting machine of all ages (Ifrah, cited in Mutlu, 2019). Fingers are recognized as the most natural tool for counting because they are universally accessible, nimble, and possess discrete quantities (Andres et al., 2008; Di Luca & Parenti, 2011; Bender & 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, & Akkuşci, 2020). Before children acquire expertise in speech production, they use their fingers to intimate, notify, and convey mathematical and numerical concepts (Berteletti & Booth, 2015; Lee, Kotsopoulos, Tumber, & Makosz, 2014). Many primary school teachers report that children seem to use fingers intuitively for counting and computation (Calder Stegemann & 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) stated that finger-counting enhances children's potential to make use of symbols 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. 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 bodies to symbolize numbers (Berteletti & 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 & Booth, 2015; Butterworth, 1999). Notwithstanding, a dichotomy exists from culture to culture in representing numerical concepts with fingers (Mutlu et al., 2020; Pika et al., 2009; Bender & Beller, 2012) to the extent that the numerical quantity conveyed may be reconstructed by 1-1 counting in the non-existence of language (Berteletti & Booth, 2015). Studies have shown that hand and finger representation have an impact on children and adults at different stages of numerical processing (Badets et al., 2010; Badets & Pesenti, 2010; Berteletti & Booth, 2015; Di Luca & Pesenti, 2008).

Studies have shown that hand compositions are naturally linked with mathematical illustration even among adults (Badets & Pesenti, 2010; Badets et al., 2010; Di Luca et al., 2006; Di Luca & Pesenti, 2008). Studies have also shown that dyscalculia children depend more on fingers when set side by side with their counterparts to speed up the accomplishment of action-specific processes (Alibali & DiRusso, 1999; Geary, 2005). Research conducted by Barrouillet and Lépine (2005) 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 & Soylu, 2013; Klein et al., 2011; Badets et al., 2010). Training children training on finger discrimination assignments improves their numerical accomplishment (Sinclair & Pimm, 2015; Gracia-Bafalluy & 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.

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. Solid foundation is used here to imply pupils' ability to learn things with better understanding and be practical without rote memorisation. Up to the present time, little is known regarding the influence of finger-counting manipulatives in creating and forming a strong numerical and arithmetical understanding. Hence, the need for more insight into the influence of the use of finger-counting manipulatives will help accomplish better educational practices and probably produce substitute means to cure difficulties encountered in learning Mathematics. It is for this reason that this study seeks to investigate the preschool, primary, special educators, and Mathematics teachers' perceived influence of finger-counting as the basis for laying a solid foundation in teaching and learning Mathematics. Specifically, look at how the preschool, primary, special educators, and Mathematics teachers in basic and secondary schools perceived influence of finger-counting as the basis for laying a solid foundation in teaching and learning Mathematics. And also investigated whether or not there were any:

(i) significant difference in teachers' perceived influence of finger-counting as the basis for a solid foundation in learning Mathematics based on gender.
(ii) teachers' perceived influence of finger-counting as the basis for a solid foundation in learning Mathematics on the category of teachers.
(iii) teachers' perceived influence of finger-counting as the basis for a solid foundation in learning Mathematics based on their years of teaching experience.

**Research Question**

What are the preschool, primary, special educators, and mathematics teachers in basic and secondary schools perceived influence of finger-counting as the basis for laying a solid foundation in teaching and learning Mathematics?

**Hypotheses**

$H0_1$: There is no significant difference in teachers' perceived influence of finger-counting as the basis for a solid foundation in learning Mathematics based on gender.

$H0_2$: There is no teachers' perceived impact of finger-counting as the basis for a solid foundation in learning Mathematics on the category of teachers.

$H0_3$: 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.

## Methods

The study employed a descriptive survey design. The population (target population) for the study was 204 consisting of preschool, primary, and special educators and Mathematics teachers in secondary schools in Lafia Local governments of Nasarawa State. 43 (43%) 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 using quota sampling in another local government of the state. The pilot testing of the instrument yielded a reliability coefficient of 0.87. The instrument was also validated by three mathematics experts at 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. Percentages and means were used for research question one, t-test for hypothesis 1, and for hypotheses 2 and 3 ANOVA was used.

## Results

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

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.

**Table 1: Percentage and the 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 | 70.0 | 29.0 | 0 | 1.0 | 3.68 | 1st |
| 2 | Finger-counting education improves mathematics performance | 62.0 | 35.0 | 3.0 | 0 | 3.59 | 2nd |
| 3 | Increases numerical, arithmetic, and problem-solving skills and also improves attitudes toward mathematics | 46.0 | 47.0 | 6.0 | 1.0 | 3.38 | 9th |
| 4 | It facilitates learning by touching. | 49.0 | 44.0 | 4.0 | 3.0 | 3.39 | 6th |
| 5 | It turns the abstract into the concrete resulting in meaningful learning | 56.0 | 39.0 | 5.0 | 0 | 3.51 | 5th |
| 6 | It is a tool that students always have with them when they need it. | 58.0 | 41.0 | 1.0 | 0 | 3.57 | 3rd |
| 7 | It makes counting practical. | 55.0 | 45.0 | 0 | 0 | 3.55 | 4th |
| 8 | I think it is more permanent | 45.0 | 47.0 | 7.0 | 1.0 | 3.38 | 9th |
| 9 | Finger-counting enhances retention | 40.0 | 55.0 | 4.0 | 1.0 | 3.34 | 11th |
| 10 | Finger-based representations improve children's ability to use symbolic figures and develop their numerical skills | 44.0 | 53.0 | 3.0 | 0 | 3.41 | 7th |
| 11 | They can internalize a subject more easily as they use their own body when they learn it | 42.0 | 57.0 | 1.0 | 0 | 3.41 | 7th |
| 12 | As students become older, they use finger-counting more than doing | 34.0 | 44.0 | 19.0 | 3.0 | 3.09 | 20th |

| S/N | Items | SA % | A % | D % | SD % | Mean | Rank |
|---|---|---|---|---|---|---|---|
| | arithmetic mentally because they find the former easier | | | | | | |
| 13 | I insist that my students use finger-counting instead of getting them to abandon using it. | 34.0 | 55.0 | 7.0 | 4.0 | 3.19 | 18th |
| 14 | A limited number of fingers negatively affects calculations | 40.0 | 45.0 | 13.0 | 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. | 34.0 | 55.0 | 7.0 | 4.0 | 3.19 | 18th |
| 16 | I receive parental support to get students to do arithmetic with finger counting at home and school often | 30.0 | 43.0 | 22.0 | 5.0 | 2.98 | 21st |
| 17 | It is limited in terms of calculation | 46.0 | 45.0 | 6.0 | 3.0 | 3.34 | 12th |
| 18 | Finger-counting turns into a habit | 43.0 | 45.0 | 9.0 | 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. | 45.0 | 45.0 | 7.0 | 3.0 | 3.32 | 13th |
| 20 | Fingers, when properly used, are a natural and already existing toolkit for modeling and reflecting digital information. | 38.0 | 58.0 | 2.0 | 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. | 43.0 | 47.0 | 8.0 | 2.0 | 3.31 | 15th |

Note: SA – Strongly agree, A – Agree, N – Neither agree nor disagree, D – Disagree, SD – Strongly Disagree

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 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, 20th, and 21st respectively.

**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 results 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 Teachers, Primary school Teachers, 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 a .05 level of significance, 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.

**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: 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 | | |

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**

| 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).

## 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 & 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 as cited in Mutlu et al., 2020) thinks that concrete objects be used to discourage students from using 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 et al., (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 perceive 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's (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-aged 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., (2016) 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., 2016).

## Conclusion and Recommendations

In promoting the working memory of the pupils/students, a more appropriate way to develop finger counting strategies in the teaching of Mathematics should be enhanced. Finger counting was not seen as an alternative or optional but as an indispensable tool in teaching and learning Mathematics.

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. The Ministry of Education should ensure that finger-counting becomes an integral part of the syllabus and enforce its use by teachers. The curriculum developer should also ensure that basic and secondary school curricula take care of this teaching skill into consideration. Lastly, parents must also encourage their wards to use finger–counting at the various homes to encourage their wards to learn faster.

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 by students, in this way it discourages rote memorizations.

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