# EFFECT OF AGE ON METAMEMORY AND FLUID INTELLIGENCE: A STUDY ON PRIMARY AND SECONDARY SCHOOLS OF ASSAM

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**Abstract**

The study aimed to examine the effect of age on Fluid Intelligence and three important aspects of Metamemory- Satisfaction, Ability and Strategy among primary and secondary school teachers of Assam. A quantitative study was conducted on 209 primary and secondary school teachers of Assam aged 20 to 59 using convenient sampling method. While Multifactorial Memory Questionnaire (MMQ, ) was used to assess metamemory , Standard Progressive Matrices (Raven , 1979) was used to measure fluid intelligence. Data was analyzed using both parametric ( one-way ANOVA ) and non-parametric ( Kruskal Wallis ) test . Results showed significant effect of age on fluid intelligence. On the contrary, no significant differences were found in terms of Metamemory (satisfaction, ability and strategy) across age. These findings provide valuable insights into the effect of age in cognitive and metacognitive dimensions, contributing to the understanding of age-related changes in educational professionals in the context of Assam and helps in reducing the gap in the literature regarding cross-sectional evidence of metacognition and fluid intelligence in the education sector which can be used to develop age-specific interventions in the education sector for either teaching professionals or the students.

*Keywords:* metamemory, fluid intelligence, age

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**Effect of age on Metamemory and Fluid Intelligence: A study of primary and secondary school teachers of Assam**

With the mind as the epicentre, cognition is the process of implicit or explicit thinking or information processing regarding any particular task or situation involving multiple levels and structures of the brain (Parren, N, 2018). Age-related changes in cognition have been studied extensively over the years. Murman D. L. (2015) conveyed that “age-related diseases accelerate the rate of neuronal dysfunction, neuronal loss, and cognitive decline, with many persons developing cognitive impairments severe enough to impair their everyday functional abilities” (Murman D. L., 2015). To effectively function in life, we need to have cognitive abilities that cater to the tasks we engage in our everyday lives. Therefore, we must understand the nature of change in cognition to design effective interventions to cope with any change as per age-wise requirements of any individual. This change in cognition also warrants the need to study the self-regulatory methods of cognition. In this regard, it is vital to examine the role of age in metacognition which refers to cognitive assessments or monitoring processes used to modify and control one’s own behaviour, especially in the case of learning and memory (Rhodes, M.G. 2019).

As early as 1988, Paris and Winogard stated that metacognition encompasses information as well as control of self and the process (Thenmozhi, C, 2019). Metamemory, the process of self-awareness about memory, is a part of the wider construct of metacognition which is one of the focal points of this study. Dixon, R.A., & Hultsch, D.F. (1983) developed a 120-item metamemory measuring instrument consisting of the following eight subscales of metamemory: “a) Use of memory strategy (Strategy); (b) Knowledge of memory tasks (Task); (c) Knowledge of own memory capacities (Capacity); (d) Attitudes toward own memory: Perception of change (Change); (e) Activities supportive of memory (Activity); (f) Memory and state anxiety (Anxiety); (g) Memory and achievement motivation

(Achievement); and (h) Locus of control in memory abilities (Locus).". They observed that younger participants performed differently than older participants, especially in the Task, Capacity, Change, and Locus dimensions.

On the other hand, General fluid intelligence or Gf is the inductive and deductive reasoning ability, specifically while dealing with novel information or situations (Cattel 1963, Cattel 1943 Kyllonen, P.C., & Kell, H.J. 2017). As early as 1944, Weschler talked about fluid intelligence and why it is important to understand it in the context of adult intelligence in his book "The Measurement of Adult Intelligence". Bugg, J. et al (2006) found evidence of age-related fluid intelligence variances due to overall slowing and frontal decline along with some unidentified factors in his study of 196 participants aged 20 to 89 years old. Gurubatham, M. (2014) highlights the importance of "cognitive literacy" which includes metacognition and fluid intelligence for conducting a successful teaching and learning model based on his experience of online discussion classes held with Malaysia, the USA, and South Africa.

These two aspects of cognition- metamemory and fluid intelligence may be crucial to understanding age-specific instructions or interventions in different personal and professional sphere of our life including educational institutions. Although research on age, metamemory and fluid intelligence is not sparse, there is a gap in the literature in the context of teaching professionals which this study has tried to address. The scope of the current study comprises of fluid intelligence and the three aspects of metamemory: satisfaction with memory functioning (satisfaction), self-appraisal of memory ability (ability), and self-reported use of memory strategies (strategy) with the help of the Multifactorial Memory Questionnaire developed by Troyer, A. K., & Rich, J. B. (2002). Moreover, this study is a cross-sectional design with four levels of age (20- 29, 30-39, 40-49 and 50-59 years) to explore the progression of metamemory and fluid intelligence in the context of teaching professionals, unlike most available studies contributing to reducing the gap in the literature. The current study hypothesizes that there are significant differences in metamemory components (satisfaction, ability and strategy) and fluid intelligence across age.

**Method**

***Study Design.*** Using a comparative design, this study quantitatively examined the nature of the relationship of age with metamemory and fluid intelligence across four levels of age - 20 to 29, 30 to 39, 40 to 49 and 50 to 59 years.

***Participants.*** G*Power was used to determine the sample size for the study. With a medium effect size of 0.25, four groups, 0.80 power and a significance level of 0.05, the required sample size was 180 participants. Therefore, for the current study, 209 participants were involved from a total of 12 primary and secondary schools of Assam which is adequate for the current study using convenient sampling method. Teachers were chosen to be a part of the study they were easily accessible , to maintain homogeneity in profession and to reduce the gap in literature.

Participants were included in the study if they were teaching at any primary or secondary school in Assam, were aged between 20 and 59 and gave informed consent. Participants were excluded from the study if they wished to withdraw or submit incomplete test. After exclusion of 15 participants due to incomplete/missing data, the final sample size came to be 191.

***Procedure and measures.*** While Multifactorial Memory Questionnaire (MMQ; Troyer, A. K., & Rich, J. B. 2002) which is a self-reported questionnaire, was used to assess the three aspects of metamemory namely, satisfaction, ability and strategy, Standard Progressive Matrices ( Raven 1979 ) which is a nonverbal reasoning test was used to assess fluid intelligence. At the very outset of the study, participants were briefed about the study and informed consent was taken. Thereafter, metamemory and fluid intelligence was tested among the participants followed by a debriefing session . The data was collected in a single sitting.

***Data Analysis.*** The Sharpo-Wilk normality test was conducted for fluid intelligence, satisfaction, ability, and strategy variables across all four age groups (Table 2). While fluid intelligence and satisfaction violated the normal distribution pattern in Age Group 1 (20 to 29 years) and strategy showed close to non-normal distribution in Age Group 4(50 to 59 years), ability followed a normal distribution across all groups. (Table 2). Further, Levene's Test was conducted to test the assumption of homogeneity of variances for the four variables. Results showed that fluid intelligence, satisfaction, and ability had $p>0.05$, indicating homogeneous variance while strategy had a p-value of 0.036 showing heterogeneous variance (Table 3).

Accordingly, as the parameters of normality and homogeneity of variance required for a parametric test was met for ability, one-way ANOVA was conducted along with Tukey's Honestly Significant Difference test to further examine group differences. On the other hand, as fluid intelligence, satisfaction and strategy variables did not meet the parameters of parametric test, Kruskal-Wallis test was performed for these variables.

**Results**

The study was conducted to see if age has any effect on fluid intelligence and metamemory. A total of 191 primary and secondary teachers were part of the study. These participants were distributed into four age groups of 20 to 29 years, 30-39 years, 40 to 49 years and 50 to 59 years (Figure 1). The sample consisted of 50 males and 141 females (Figure 2). Interesting evidence was found in the study.

Descriptive analysis was conducted for all four variables—fluid intelligence, satisfaction, ability, and strategy. As illustrated in Table 1, fluid intelligence scores ranged from 17 to 59, with a mean score of 41.85 and a standard deviation of 8.15. The data was relatively balanced but slightly flatter than a typical bell curve (Figure 3). Satisfaction scores ranged from 22 to 63, with a mean of 46.99 and a standard deviation of 7.43. Data was slightly negatively skewed with a small peak compared to a normal curve, suggesting a concentration of scores near the average (Figure 4). Ability scores ranged from 26 to 78, with a mean of 53.33 and a standard deviation of 9.53. Data was a nearly perfect symmetrical distribution, indicating the absence of any extremes (Figure 5) Finally, strategy scores ranged from 8 to 63 and the highest variability among the four variables, with a mean of 31.93 and a standard deviation of 11.17. Data was slightly skewed to the right but was relatively normally distributed (Figure 6).

Results of one-way ANOVA for ability (Table 4) indicated no significant differences in ability scores across the four groups with $F(3,187)=0.752$ and $p=0.523$. Further post hoc comparisons with Tukey's HSD revealed that there were no observed significant differences between any age groups with $p>0.05$ for all comparisons (Table 5).

Consequently, the results of the Kruskal-Wallis test conducted for fluid intelligence, satisfaction and strategy variable are illustrated in table 6 and table 7. Results for fluid intelligence revealed significant difference across groups with Test Statistic (H) of 21.063, Degrees of Freedom (df) of 3 and p =< 0.01. the youngest group (20 to 29 years) or age group 1 had the highest rank of 124.02 followed by age group 2 (30 to 39 years) with rank of 100.63 and age group 3 (40 to 49 years) with a rank of 87.41 and with the oldest group (50 to 59 years) or age group having the lowest rank of 73.50. This gradual decline of fluid intelligence with age from the youngest group to oldest group shows that younger individuals are likely to have a higher level of fluid intelligence than older individuals.

On the other hand, no significant difference was found across groups for the satisfaction variable with p=.912. However, age group 1(20 to 29 years) had the highest rank of 98.88 followed by near similar ranks for age group 2 (30 to 39 years) with a rank of 97.10 and age group 4 (50 to 59 years) with a rank of 97.03. Interestingly age group 3 (40 to 49 years) had the lowest satisfaction rank of 91.13. Although it was not substantial, the youngest group were the most satisfied of all the four groups. Additionally, except in group 3, we can see a minimal decline in satisfaction with age.

Similarly, the strategy group presented no significant difference across groups with Test Statistic (H) of 0.784, Degrees of Freedom (df) of 3 and p = 0.853 which is significantly greater than p=0.05 . In the test, group 1(20 to 29 years) had a mean rank of 101.83 (highest rank), group 2 had a mean rank of 96.04, group 3 had mean rank of 94.42 and group 4 had a mean rank of 92.07 (lowest rank) (Table 8). Interestingly, Group 1 (20 to 29 years) had a higher rank of 101.83 than any of the other groups showing a very slight decline with age even though not significantly so.

**Discussion**

The primary goal of the study was to examine whether age has any effect on fluid intelligence and metamemory (satisfaction, ability and strategy). In the fluid intelligence test, younger individuals had a higher level of fluid intelligence than older individuals showing a gradual decline from younger to older participants. Previous research supports this negative relationship between age and fluid intelligence (Kievit et al., 2018). Apart from age, this decline in fluid intelligence with age has been attributed to individual differences in white- and grey matter (Kievit et al., 2018) and physical health (Bergman, I., & Almkvist, O, 2013). In the study by Bergman, I., & Almkvist, O (2013) consisting of 118 participants aged 26 to 91, physical health was found to have a mediating influence on the age-related decline in fluid intelligence.

There was no significant difference across the four age groups for satisfaction, ability and strategy variable. This means that regardless of their age, people assess their satisfaction with their own memory relatively similarly along with their everyday memory mistakes and apply similar amount of strategies. This is supported by former research where no significant relationships were found between age and seven metamemory factors of Strategy, Task, Capacity, Change, Anxiety, Achievement, and Locus with older participants scoring higher than the younger participants in the Strategy factor implying that older participants used more strategies than older participants (McDougall, G. ,1994). In the current study, although it was not substantial, the youngest group scored slightly higher on the metamemory aspects of satisfaction and strategy than the older participants. This might be because the sample size is too small to detect a significant effect. Therefore, further studies with a larger sample are required in this regard. The complexity of metamemory as a construct also warrants complexities in age-related effects on metamemory. Some earlier research evidence suggests that older adults have lower metamemory accuracy as they are overconfident in their performance or have a more impaired recollection quality than younger ones depicting a significant effect of ageing on metamemory (Bunnell et al,1999; Wong, J.T et al 2012; Yeung, M.K, 2024). Such deficits in metamemory may lead to shortfalls in working memory in the ageing population (Bunnell et al,1999). However, interventions focused on increasing metacognitive accuracy can positively affect any age-related memory decline (Yeung, M.K, 2024).

***Limitations.*** The study's limitations include that the data for this study violated either or both parameters of the parametric test of normality and homogeneity of variance. Additionally, a more objective measurement tool for metamemory can be taken to avoid response bias like in the case of self-report questionnaires. Moreover, further studies may be conducted with a larger sample size to detect significant effects of age on metamemory.

***Future Implications.*** In the field of education, investigating metamemory and fluid intelligence could benefit teaching professionals by creating age-specific interventions or faculty development programs. On the other hand, it may also help in holistically teaching the students so that along with memory, analytical, creativity and pragmatism are also emphasized, leading students to benefit from individual strengths and cope with any disadvantage they might possess in terms of cognition (Sternberg, R.J., & Grigorenko, E.L. 2004). Since physical health was found having mediating influence on the age-related decline in fluid intelligence a healthy lifestyle could help compensate the detrimental effect of age on fluid intelligence by thwarting at risk factors like age-related circulatory- and nervous system diseases (Bergman, I., & Almkvist, O, 2013).

## Conclusion

Overall, the findings highlight the significant effect of age on fluid intelligence. Bergman, I., & Almkvist, O. (2013) highlighted the importance of maintaining physical health to cope with age-related decline in fluid intelligence. For metamemory, although statistically, no meaningful differences in satisfaction, ability, or strategy were found, interventions focused on increasing metacognitive accuracy can positively affect any age-related memory decline (Yeung, M.K., 2024). Further studies planned with a larger sample size may be crucial to fully understand the effect of age on metamemory.

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**Tables and Figures**

**Table 1**
*Descriptive Statistics of fluid intelligence and metamemory components*

| | N | Minimum | Maximum | Mean | Std. Deviation | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| fluid intelligence | 191 | 17 | 59 | 41.85 | 8.149 | -.115 | .176 | -.449 | .350 |
| satisfaction | 191 | 22 | 63 | 46.99 | 7.425 | -.636 | .176 | .557 | .350 |
| ability | 191 | 26.0 | 78.0 | 53.333 | 9.5253 | -.017 | .176 | .020 | .350 |
| strategies | 191 | 8 | 63 | 31.93 | 11.174 | .313 | .176 | -.050 | .350 |

**Table 2**
*Shapiro – Wilk test of normality of fluid intelligence and metamemory components*

| | | Statistic | df | Sig. |
|---|---|---|---|---|
| FI | 1 | .943 | 45 | .028 |
| | 2 | .973 | 50 | .305 |
| | 3 | .991 | 48 | .964 |
| | 4 | .981 | 48 | .619 |
| satisfaction | 1 | .947 | 45 | .039 |
| | 2 | .963 | 50 | .118 |
| | 3 | .969 | 48 | .224 |
| | 4 | .963 | 48 | .133 |
| ability | 1 | .976 | 45 | .477 |
| | 2 | .958 | 50 | .071 |
| | 3 | .986 | 48 | .830 |
| | 4 | .971 | 48 | .277 |
| strategies | 1 | .979 | 45 | .561 |
| | 2 | .982 | 50 | .623 |
| | 3 | .983 | 48 | .690 |
| | 4 | .968 | 48 | .216 |

Significant at P<0.05

**Table 3**
Levene *Test of Homogeneity of Variances*

| | | Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|---|
| Fluid intelligence | Based on Median | .682 | 3 | 187 | .564 |
| Satisfaction | Based on Median | .251 | 3 | 187 | .860 |
| Ability | Based on Median | 1.725 | 3 | 187 | .163 |
| Strategies | Based on Median | 2.915 | 3 | 187 | .036 |

Significant at P<0.05

**Table 4**
*One –way ANOVA table for ability*

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| ability | Between Groups | 205.439 | 3 | 68.480 | .752 | .523 |
| | Within Groups | 17033.544 | 187 | 91.088 | | |
| | Total | 17238.982 | 190 | | | |

Significant at P<0.05

**Table 5**

*Results of Post Hoc Comparisons using Tukey's HSD for ability*

| Dependent Variable | | (I) age_group | (J) age_group | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|---|---|---|
| ability | Tukey HSD | 1 | 2 | -2.4467 | 1.9611 | .597 | -7.530 | 2.637 |
| | | | 3 | -.3242 | 1.9804 | .998 | -5.458 | 4.810 |
| | | | 4 | .0092 | 1.9804 | 1.000 | -5.125 | 5.143 |
| | | 2 | 1 | 2.4467 | 1.9611 | .597 | -2.637 | 7.530 |
| | | | 3 | 2.1225 | 1.9286 | .690 | -2.877 | 7.122 |
| | | | 4 | 2.4558 | 1.9286 | .581 | -2.544 | 7.455 |
| | | 3 | 1 | .3242 | 1.9804 | .998 | -4.810 | 5.458 |
| | | | 2 | -2.1225 | 1.9286 | .690 | -7.122 | 2.877 |
| | | | 4 | .3333 | 1.9482 | .998 | -4.717 | 5.384 |
| | | 4 | 1 | -.0092 | 1.9804 | 1.000 | -5.143 | 5.125 |
| | | | 2 | -2.4558 | 1.9286 | .581 | -7.455 | 2.544 |
| | | | 3 | -.3333 | 1.9482 | .998 | -5.384 | 4.717 |

**Table 6**

*Ranking results of Kruskal-Wallis Test for fluid intelligence, satisfaction and strategy*

**Ranks**

| | age_group | N | Mean Rank |
|---|---|---|---|
| FI | 1 | 45 | 124.02 |
| | 2 | 50 | 100.63 |
| | 3 | 48 | 87.41 |
| | 4 | 48 | 73.50 |
| | Total | 191 | |
| satisfaction | 1 | 45 | 98.88 |
| | 2 | 50 | 97.10 |
| | 3 | 48 | 91.13 |
| | 4 | 48 | 97.03 |
| | Total | 191 | |
| strategies | 1 | 45 | 101.83 |
| | 2 | 50 | 96.04 |
| | 3 | 48 | 94.42 |
| | 4 | 48 | 92.07 |
| | Total | 191 | |

**Table 7**

*Results of test statistics of Kruskal Wallis test for fluid intelligence, satisfaction and strategies*

| | FI | satisfaction | strategies |
|---|---|---|---|
| Kruskal-Wallis H | 21.063 | .533 | .784 |
| df | 3 | 3 | 3 |
| Asymp. Sig. | .000 | .912 | .853 |

Significant at < 0.05

**Figure 1**

*Age group distribution*

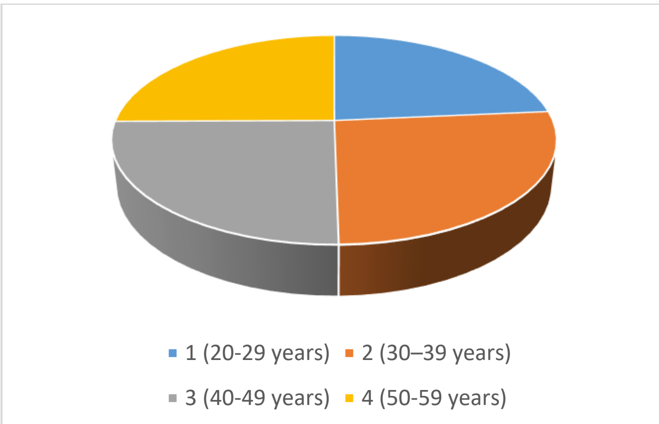


**Figure 2**

*Gender Distribution of participants*

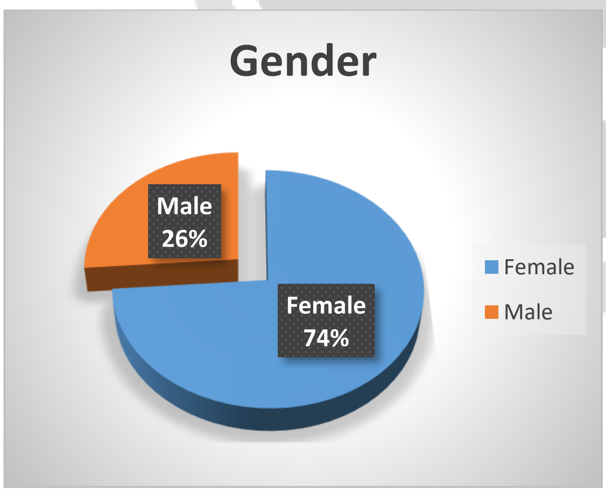

**Figure 3**

*Histogram of fluid intelligence*

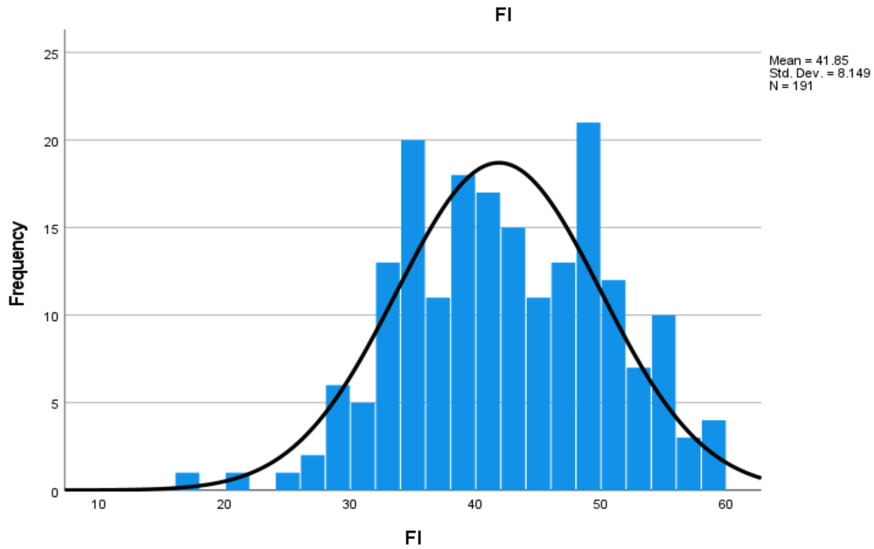


**Figure 4**
*Histogram of satisfaction*

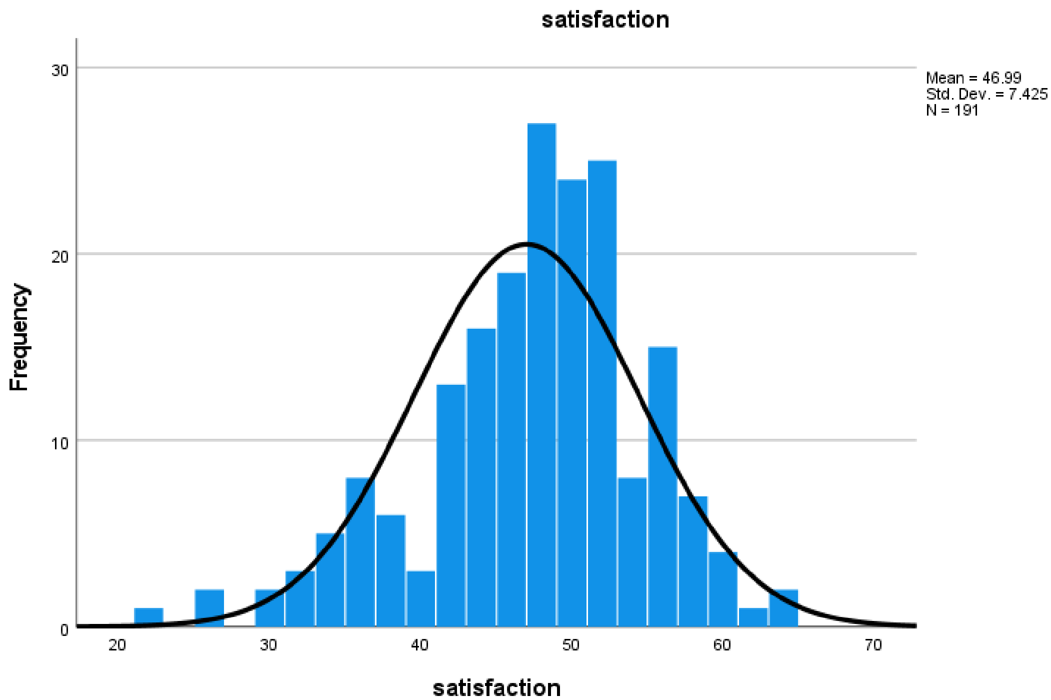


**Figure 5**
*Histogram of ability*

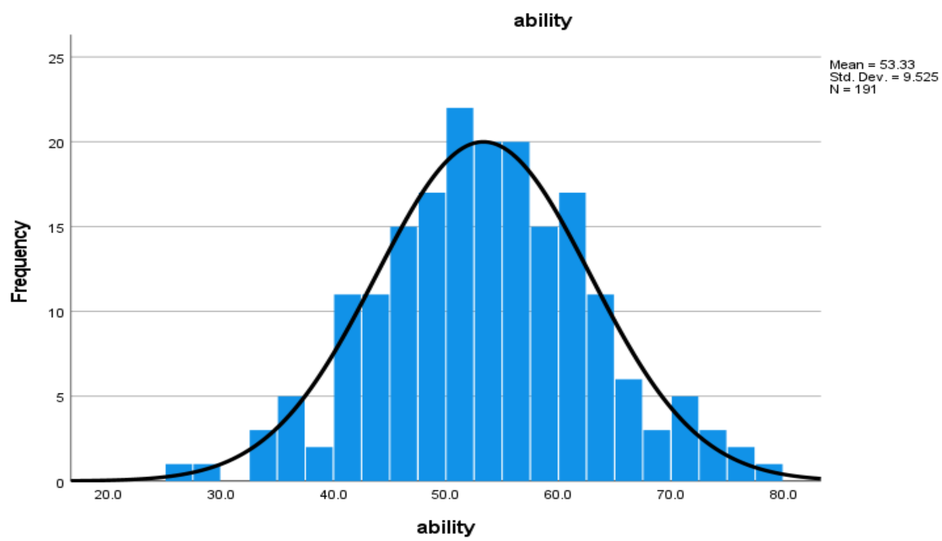


**Figure 6**
*Histogram of strategies*