International Journal of Soft Computing 10 (6): 405-407, 2015
ISSN: 1816-9503

Popularity and Gender Differences in Solving Sudoku Game among Some Sampled Secondary School Students in Lagos, Nigeria

[1]H.I. Okagbue, [2]M.O. Adamu, [1]A.A. Opanuga, [3]Z.O. Omogbadegun and [4]E.C.M. Obasi
[1]Department of Mathematical Sciences, Covenant University, Canaanland, Ota, Nigeria
[2]Department of Mathematics, University of Lagos, Akoka, Lagos, Nigeria
[3]Department of Computer and Information Sciences, Covenant University, Canaanland, Ota, Nigeria
[4]Department of Mathematical, Computer and Physical Sciences, Federal University, Otuoke, Nigeria

Abstract: The 668 students from 3 secondary schools were randomly selected and were given different Sudoku of 3 levels of difficulty namely: easy, medium and hard. All of them were given the same time to provide the different solutions. Hu used the same level of Sudoku in their research but this research extended to different levels with the aim of testing the popularity of the game among the students and gender differences in solving Sudoku. Findings showed that the game is more popular among the male and more female were unable to solve the game. The χ^2-test statistic of the 3 tables showed that there is no association between gender and the ability to solve Sudoku game. In other to get a valid conclusion, the information from the 3 tables are combined using the methods prescribed by Radhakrishna and Everitt which showed that there is association between gender and the ability to solve Sudoku. Conclusion without combining the contingency tables would have produced an incorrect analysis and wrong interpretation.

Key words: Sudoku, gender, contingency tables, Chi-square, game

INTRODUCTION

Adolescents and teenagers are often addicted to games. The advent of computers have greatly aided in the proliferation of different types of games of which Sudoku is one of them. Sudoku is a number puzzle and the detailed description can be accessed from the Wikipedia. Sudoku is believed to have originated from Japan but it does not require special numeracy skills. Lee *et al*. (2008) presented a theory on how Sudoku puzzles can be solved. The research was to investigate the gender differences in the solving of Sudoku, irrespective of the level of difficulty of the game among 3 selected mixed secondary school students. A similar research have appeared in literature where Hu *et al*. (2014) found from observation that there were no differences between the capabilities of undergraduate and postgraduate students in solving the same level of Sudoku. Since, Sudoku is a game and one of the objectives of game is to improve the cognitive ability and logical thinking of humans, we are looking at some literatures that attest to that as it relates to the Sudoku game. Several researchers have attempted to establish that Sudoku can help improve the cognitive ability of people, especially people with special needs. For example Parkinson's patients (Nombela *et al*., 2011), motion disabilities, semantic dementia (Papagno *et al*., 2013).

Grabbe (2011) wrote that Sudoku performance had a significant relationship to working memory and Jackson *et al*. (2012) found out from observation that Sudoku and Crossword puzzles can help improve and increase cognitive ability in older adults. Research findings from Chang and Gibson (2011) showed that there are differences in accuracy of solving odd and even Sudoku puzzle.

MATERIALS AND METHODS

The 3 mixed secondary (high) schools were randomly chosen and different samples of 9×9 Sudoku were administered to randomly chosen students of the schools in Lagos, Nigeria. The Sudoku were accessed from www.websudoku.com. Only basic information of the game was given to students to avoid the introduction of bias. The Sudoku were randomly generated from the website and the three levels of difficulty namely: easy, medium and hard were administered to the students. Each student was given a unique Sudoku with a level of difficulty. The level of difficulty was not known to both the researchers and the students. The same time was given to every student to complete the game.

Researchers were interested in the popularity of the game among the students and most importantly, whether there is a gender difference in the solving Sudoku with level of difficulty remaining constant.

Corresponding Author: H.I. Okagbue, Department of Mathematical Sciences, Covenant University, Canaanland, Ota, Nigeria

The data of the different schools are arranged in categorical tables and in other to arrive at a general conclusion, the 3 information in the 3 tables were combined using different methods. The details of the theories and methodology of contingency tables can be seen in the research by Bennett and Hsu (1960), Bishop (1969), Armitage (1971), Fleiss and Everitt (1971) and Brunden (1972).

RESULTS

The data from the 3 schools are arranged in 2×2 contingency table which is across-tabulation of the frequencies of the ability to solve Sudoku against the gender. The data from the 3 high schools were analyzed independently and later combined together to yield the final result (school A, Table 1).

In this school, a total of 142 students comprising of 72 males and 70 females were randomly selected and were given Sudoku of different level out of difficulty. A total of 93 admitted that they cannot solve them while 49 actually gave a unique solution to those Sudoku. The χ^2-test statistic of the data is 1.84 which is less than the tabulated value of 7.81 at $\alpha = 0.05$level of significance. The result is insignificant (school B, Table 2).

In this school, a total of 270 students comprising of 140 males and 130 females were randomly selected and were given Sudoku of different level of difficulty. A total of 182 admitted that they cannot solve them while 88 actually gave a unique solution to those Sudoku. The χ^2-test statistic of the data is 1.84 which is less than the tabulated value of 7.81 at $\alpha = 0.05$ level of significance. The result is insignificant (school C, Table 3).

In this school, a total of 256 students comprising of 120 males and 136 females were randomly selected and were given Sudoku of different level out of difficulty. A total of 184 admitted that they cannot solve them while 72 actually gave a unique solution to those Sudoku. The χ^2-test statistic of the data is 2.14 which is less than the tabulated value of 7.81 at $\alpha = 0.05$ level of significance. The result is insignificant.

The summary of the χ^2-tests of independence showed that gender is independent with the ability to solve Sudoku. The research was further extended to obtaining information when the three 2×2 contingency tables are combined to a single 2×2 contingency table. The objective is to get a unified conclusion from the different contingency when their information is combined. For theories, methodologies of contingency tables, see; Goodman and Kruskal (1954), Bennett and Hsu (1960), Mantel (1963) and Aitkin (1979).

Radhakrishna (1965) outlined some techniques for combining different 2×2 contingency tables. All the data from the 3 tables of the schools are combined together to form a single 2×2 table (Table 4). The χ^2-test statistic is computed to be 10.87. The result is significant at $\alpha = 0.05$.

Add up all the chi-square values separately for the contingency tables and the resulting Chi-square value is compared with the tabulated value of the Chi-square table with n degrees of freedom. Where n is the number of the tables, here n = 3:

$$\chi^2 = 1.84 + 7.27 + 2.14 = 11.25$$

The result is also significant at $\alpha = 0.05$. Using the $\sqrt{\chi^2}$ Method (Table 5). For this method the effective, the tables must not differ greatly (Radhakrishna, 1965). The proportion of the attributes will lie between 0.2 and 0.8:

$$Z = \frac{\sum\chi}{\sqrt{n}} = \frac{1.3565 + 2.6963 + 1.4629}{\sqrt{3}} = 3.1844$$

The value is referred to the standard normal table and the result is significant at $\alpha = 0.05$.

Table 1: Contingency table for school A

Parameters	Cannot solve	Can solve	Total
Female	51	21	72
Male	42	28	70
Total	93	49	142

Table 2: Contingency table for school B

Parameters	Cannot solve	Can solve	Total
Female	98	32	130
Male	84	56	140
Total	182	88	270

Table 3: Contingency table for school C

Parameters	Cannot solve	Can solve	Total
Female	103	33	136
Male	81	39	120
Total	184	72	256

Table 4: The combined data of the 3 contingency tables

Parameters	Cannot solve	Can solve	Total
Female	252	86	338
Male	207	123	330
Total	459	209	668

Table 5: Summary of the procedures for the $\sqrt{\chi^2}$ Method

Parameters	Cannot solve	Can solve	Proportion	χ^2	$\sqrt{\chi^2}$
Female	51	21	0.290	1.84	1.3565
Male	42	28	0.400	-	-
Total	93	49	-	-	-
Female	98	32	0.250	7.27	2.6963
Male	84	56	0.400	-	-
Total	182	88	-	-	-
Female	103	33	0.240	2.14	1.4629
Male	81	39	0.325	-	-
Total	184	72	-	-	-

Table 6: The summary of the students selected for the research in percentages

Parameters	Cannot solve	Can solve	Total
Female	37.7	12.9	50.6
Male	31.0	18.4	49.4
Total	68.7	31.3	100.0

DISCUSSION

The summary of all the students that are selected and participated in this research is summarized in Table 6 in percentages.

In all the 3 schools sampled, the numbers of students that can solve Sudoku are less than those that can solve them. The numbers of female are slightly higher but more female constituted the greater percentage of those that cannot solve Sudoku. The greater percentages of male students that can solve Sudoku and lower percentages of the female that can solve Sudoku indicate that the game is popular among the male. Consequently, the higher percentage of female that cannot solve the game also showed lower popularity of the game among them.

The differences among the 3 contingency tables do not differ greatly. The χ^2-tests of independence of the separate tables are all insignificant; there is no association between gender and the ability to solve Sudoku.

The χ^2-tests of independence of combination of the information of the 3 schools (contingency tables) using 3 methods are all significant. There is an association between gender and the ability to solve Sudoku game.

CONCLUSION

Sudoku game is more popular among the male students. There is association between gender and the ability to solve Sudoku based on the results of the analysis of the data collected from the 3 students. Further, research is needed for a generalized conclusion.

REFERENCES

Aitkin, M., 1979. A simultaneous test procedure for contingency table models. Appl. Stat., 28: 233-242.

Armitage, P., 1971. Statistical Methods in Medical Research. 1st Edn., Blackwell Scientific Publication, New York, pp: 217-220.

Bennett, B.M. and P. Hsu, 1960. On the power function of the exact test for the 2×2 contigency table. Biometrika, 47: 393-398.

Bishop, Y.M., 1969. Full contingency tables, logits and split contingency tables. Biometrics, 25: 383-399.

Brunden, M.N., 1972. The analysis of non-independent 2×2 tables using rank sums. Biometrics, 28: 603-607.

Chang, H.S. and J.M. Gibson, 2011. The odd-even effect in sudoku puzzles: Effects of working memory, aging and experience. Am. J. Psychol., 124: 313-324.

Fleiss, J.L. and B.S. Everitt, 1971. Comparing the marginal totals of square contingency tables. Br. J. Math. Stat. Psychol., 24: 117-123.

Goodman, L.A. and W.H. Kruskal, 1954. Measures of association for cross classifications. J. Am. Stat. Assoc., 49: 732-764.

Grabbe, J.W., 2011. Sudoku and working memory performance for older adults. Act. Adaptation Aging, 35: 241-254.

Jackson, J.J., P.L. Hill, B.R. Payne, B.W. Roberts and E.A. Stine-Morrow, 2012. Can an old dog learn (and want to experience) new tricks? Cognitive training increases openness to experience in older adults. Psychol. Ging, 27: 286-292.

Lee, L.N.Y., G.P. Goodwin and P.N. Johnson-Laird, 2008. The psychological puzzle of Sudoku. Thinking Reasoning, 14: 342-364.

Mantel, N., 1963. Chi-square tests with one degree of freedom; extensions of the mantel-haenszel procedure. J. Am. Stat. Assoc., 58: 690-700.

Nombela, C., P.J. Bustillo, P.F. Castell, L. Sanchez, V. Medina and M.T. Herrero, 2011. Cognitive rehabilitation in Parkinson's disease: Evidence from neuroimaging. Front. Neurol., 2: 1-82.

Papagno, C., C. Semenza and L. Girelli, 2013. Meeting an "impossible challenge" in semantic dementia: Outstanding performance in numerical Sudoku and quantitative number knowledge. Neuropsychol., 27: 680-690.

Radhakrishna, S., 1965. Combination of results from several 2×2 contingency tables. Biometrics, 21: 86-98.