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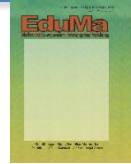
Factors Influencing Mathematics Learning: Path Analysis

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a b s t r a c t

The factors that influence the learning of mathematics are very diverse. On this occasion, the focus is on gender, learning styles, learning independence, and motivation. These factors are fascinating because they always appear in learning and research themes. This study aimed to examine how the influence of these factors on learning achievement. This research is associational research which is a descriptive research methodology. The research subjects are 5th-semester students who take calculus courses, mathematics education study program, Universitas Muhammadiyah Purwokerto. The instruments used in this study were questionnaires and learning outcomes tests. To analyze the data used LISREL (Linear Structural Relationship) software. The results showed that not all variables affect each other directly. Gender influences learning motivation. Learning style has an impact on learning motivation. Learning motivation affects learning independence. Learning independence influences learning achievement. Learning motivation influences learning achievement. If it is seen how they influence learning achievement, then learning motivation has the most significant impact compared to gender, learning style, and learning independence.

K e y w o r d s :

Gender; Independent learning; Learning style; Motivation; Path analysis

INTRODUCTION

Studying and learning processes are the process of students acquiring their knowledge. Its implementation is influenced by various elements, such as environment, sources, media, models, and the individual's internal. Learning outcomes mostly measure indications of the success of the studying and learning process. This aims to find out how to achieve the learning objectives that have been previously set. Factors that affect student achievement include gender, learning style, learning independence, and motivation.

Gender has always been a hot issue that always appears in life. For example, there are often differences in treatment in the work and learning process. For example, technology-based jobs are usually done by men. The verbal-based subject matter is more directed at women. Spatial mathematics is more worrying for women (Casey & Ganley, 2021).

Learning style is a method used by each individual in understanding and processing information (Kolb, 2015). Students' learning style is also a characteristic of obtaining, influencing, and responding to reports (Felder & Brent, 2005). With this definition, each individual has a different learning style. Learning styles are divided into visual, auditory, and kinesthetic (Rose & Nicholl, 1997). Visual learning style is easier to remember what is seen (DePorter & Hernacki, 1993). The auditory learning style is the opposite of the visual learning style. This learning style is easier to remember what is heard or said (DePorter & Hernacki, 1993). Kinesthetic learning style is easier to remember what is touched or moved (DePorter & Hernacki, 1993). This variety of learning styles influences students' mathematical abilities (Yudha, 2019).

Independent learning is the individual ability to determine goals, materials, experiences, time to work together, and evaluation of learning. Independent learning is influenced by several factors: motivation, attitudes, habits, and academic abilities (Harvey & Chickie-Wolfe, 2007). Independent learning allows students to work efficiently and without pressure (Houston & Lazenbatt, 1996). Motivation is the reason an individual performs a confident attitude (Ames, 1992; Middleton & Spanias, 1999). Therefore, motivation is also very influential in learning. Motivation is influenced and shaped by one's self-identity, including gender (Eccles & Wigfield, 2020; Yunus & Wan Ali, 2009).

Once these factors are important, the field has not yet studied how they are related. Most of the research that has been done has only focused on linking it with learning achievement. With this condition, in this article and testing the effect on learning achievement, it is also to see the influence among variables. The variables selected in this article include gender, learning style, independent learning, and learning motivation. Path analysis is carried out in this article, which aims to see whether there is a relationship among these variables. The presentation of path analysis is carried out in detail to see how the paths' sequences are removed. In addition, it aims to facilitate understanding the analysis process if data is obtained that does not fit.

METHODS

This research is associational research which is a descriptive research methodology. The purpose of this study was to describe the relationship between variables. Association studies help researchers understand events in their entirety, and an example of associational research is the correlation and causal-comparative methodology (Fraenkel et al., 2012). Following the principles of association research, this study determined the relationship between age, learning style, learning independence, and motivation to student achievement. The effect of these variables is illustrated through a path diagram to understand these variables' direct impact and significance.

The subjects of this study were students who took calculus courses in the mathematics education study program at the Universitas Muhammadiyah Purwokerto. Of the students, 21% were male and 72% female. The instruments used in this study were questionnaires and learning outcomes tests. Questionnaires are used to determine student learning styles and measure learning independence and student learning motivation. The learning outcomes test is used to measure student achievement.

To analyze the data used LISREL (Linear Structural Relationship) software. Structural equation models help researchers assess, modify, utilize, and develop theories (Anderson & Gerbing, 1988). One type of structural equation model is path analysis, which aims to analyze the relationship between the observed variables. Therefore, the researcher used path analysis to explain the data's connection. The steps are to investigate the path according to the predetermined initial image. If the data analysis's conclusion fits, proceed with summarising the data. If the data analysis conclusion is not yet fit, the path is reduced and analyzed again.

RESULT AND DISCUSSION

Result

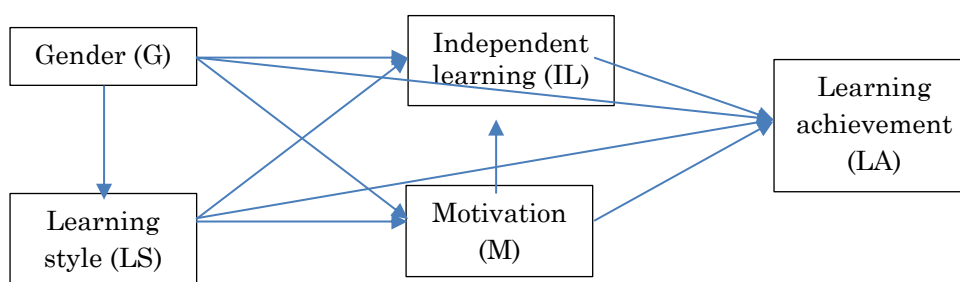The initial hypothesis of this study can be illustrated in Figure 1 below.

Figure 1
Research Path

In Figure 1, it can be seen that the hypotheses in this study are 1) whether there is an influence of gender on motivation, 2) whether there is an influence of gender on learning styles, 3) whether there is an influence of gender on motivation, and 4) whether there is an influence of gender on learning achievement. The hypotheses on learning styles are 1) whether there is an influence of learning styles on learning independence, 2) whether there is an influence of learning styles on learning motivation, and 3) whether there is an influence of student learning styles on student achievement. The hypotheses on learning

motivation are 1) whether there is an influence of learning motivation on student learning independence and 2) whether there is an influence of learning motivation on learning achievement. The last hypothesis is whether there is an influence of independent learning on student learning achievement.

The data obtained from the research results are according to the following table

Table 1. Questionnaire and Test Results

No	Variable	Min	Max	Mean	SD
1	Independent learning	65	96	82,9	7,15
2	Motivation	60	84	72,4	5,56
3	Learning achievement	40,38	87,9	68, 81	11,03

Table 1 can be seen about the results of questionnaires and student learning outcomes tests. In independent learning, the lowest score is 65, the highest score is 96, the average is 82.9, and the standard deviation is 7.15. On motivation, the lowest score was 60, the highest score was 84, the average was 72.4, and the standard deviation was 5.56. In achievement, the lowest score is 40.38, the highest score is 87.9, the average is 82.9, and the standard deviation is 7.15. The gender in the class studied were 21% male and 72% female. The learning styles in the class looked were 42.4% auditory, 21.2% visual, and 36.4% kinesthetic.

The path diagram given in Figure 1 shows the effect among variables they are gender, learning style, learning independence, and motivation on learning achievement. Path analysis was conducted to determine how and to what extent these variables affect learning achievement. In Figure 2, we can see the results of the first Path Analysis using the LISREL program.
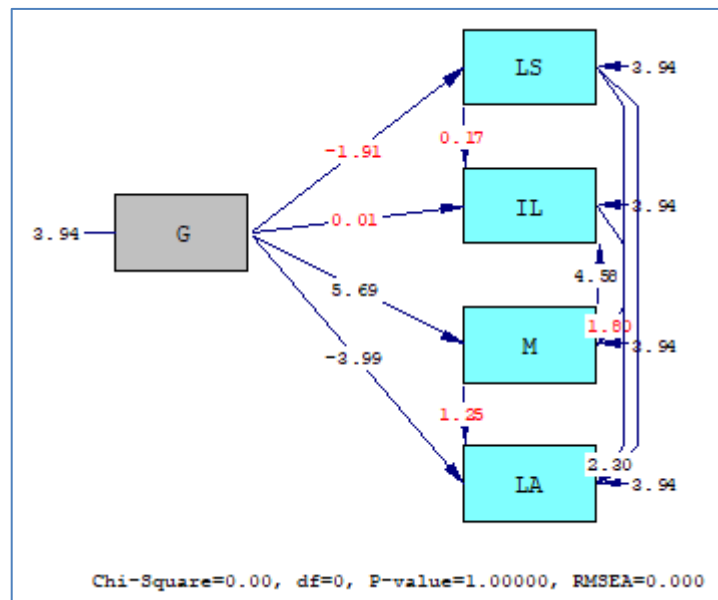

Figure 2
The Results of the First Path Analysis

In Figure 2, it appears that the path is not fit yet. This is because to achieve fit, the Chi-Square value must be less than two times df (Arbuckle & Wothke, 1995), a p-value is more

than 0.05 (Pedhazur, 1997), RMSEA is less than or equal to 0.08 (Browne & Cudeck, 1992), and GFI is more than or equal to 0.9 (Pedhazur, 1997). From Figure 2, the value of chi-square is still similar to twice df. Therefore, it is concluded that the data does not fit.

Because it is not fit, the data processing is repeated. This step begins by eliminating the path with the red criteria, negative value, or the smallest path (Pedhazur, 1997). In Figure 2, it can be seen that the G-LS route is the path with these criteria. After the G-LS pathway is removed, it is continued with re-analysis and is obtained, as shown in Figure 3 below.
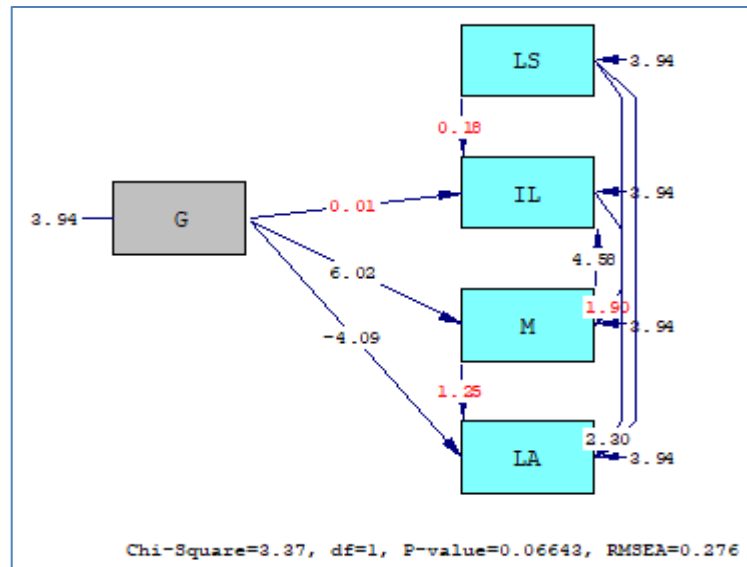

Figure 3
The Results of the Second Path Analysis

In Figure 3, it appears that the G-LS line has been removed. In addition, it also seems that the value of chi-square (3.37) is more significant than twice df. The RMSEA value (0.276) is greater than 0.08. With this condition, the data with this path is still not fit. Therefore it is necessary to eliminate the return path. The picture shows that the path with the t value is red, and the smallest path is the G-IL path, so this path is omitted. The results of the analysis are as in Figure 4 below.
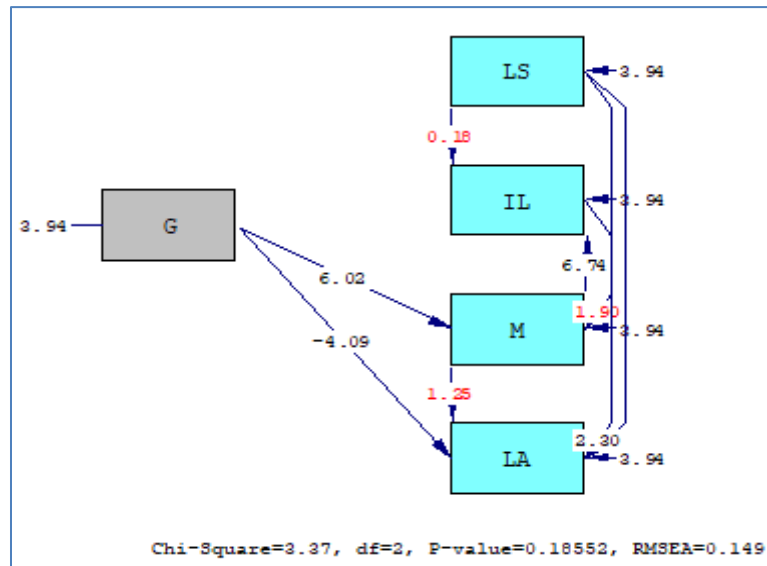
Figure 4
The Results of the Third Path Analysis

Figure 4 shows that the G-IL line has been removed. In addition, it also appears that the RMSEA value (0.149) is more significant than 0.08. With this condition, the data with this path is still not fit. Therefore it is necessary to eliminate the return path. Figure 4 shows that the path with the t value is red, and the most minor path is the LS-IL path, so this path is omitted. The results of the analysis are shown in Figure 5 below.
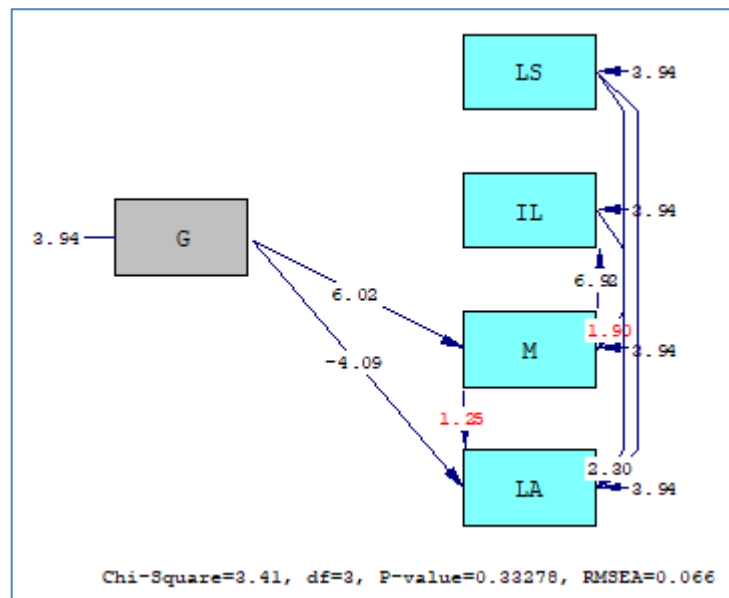
Figure 5
The Results of the Fourth Path Analysis

In Figure 5, it appears that the LS-IL path has been removed. In addition, it also appears that all values have been fit. This can be seen from the chi-square value (3.41), which is less than twice df (6), the p-value (0.333) is greater than 0.05, and the RMSEA value (0.066) is less than 0.08. When viewed from the results of the lisrel output, the GFI value of 0.96 is obtained. Because it is greater than 0.9, this data is said to fit.

Because this research is only for hypothesis testing, not for model development, then this fit condition is sufficient. The next step is to see the significance of the path. The process is by first summarising the required data. The data includes Standardised Solution, Correlation Matrix of Y and X, and Standardized Total and Indirect Effects. The summary results are in table 2. In table 2, to find out which influence is greater, it can be seen in the correlation coefficient column. The level of significance between variables can be seen in the direct effect column.

Table 2. Questionnaire and Test Results

Variable	Correlation coefficient	Total effect (TE)	Direct effect (DE)	Indirect effect (IE)	S
G – LS	-	-	-	-	
G – IL	0,56	0,56	-	0,56	0
G – M	0,72	0,72	0,72	-	0
G – LA	-0,30	-0,30	-0,81	0,51	0
LS – IL	0,18	0,18	-	0,18	0
LS – M	0,23	0,23	0,23	-	0
LS – LA	0,2	0,20	0,04	0,16	0
M – IL	0,78	0,78	0,78	-	0
IL – LA	0,30	0,49	0,49	-	0,19
M – LA	0,14	0,71	0,33	0,38	0,57

Discussion

From table 2, we can explore various information related to the variables studied. To answer the hypothesis related to how the influence between variables can be seen in the DE column. From this column, it can be seen that the interactions between variables that have a significant effect are gender and learning motivation (G-M), learning style with learning motivation (LS-M), learning motivation with learning independence (M-IL), learning independence with learning achievement (IL-LA), and learning motivation with learning achievement (M-LA). Explanation in detail as follows:

Gender and learning motivation

The scope of motivation is quite broad because it can be in the form of internal and external motivation. Gender affects learning motivation. The problem-based learning model shows that female students have higher learning than boys (Tanaka, 2022). Gender and learning motivation affect each other due to the nature of the calculus material. The primarily analytical calculus material is identical to the female gender. This is because the nature of women is dominant in the analysis, not in the form of spatial analysis. Although gender is significant to motivation, gender is not significant to other variables. Gender has no significant impact on a person's learning style (Baltaci et al., 2016).

Learning styles and learning motivation

Learning styles also significantly affect motivation because each has a different kind. The form of learning is classical, made in groups, and group members take turns at each meeting. With conditions like this, where there is a change in group members at each session, it can affect students with diverse learning styles. These conditions ultimately lead to their learning motivation. Different learning styles, including visual, auditory,

and kinesthetic, can significantly influence students' learning motivation (Demİr-Ayaz, 2022).

Learning motivation with learning independence

From table 2 it can be seen that the highest direct effect (DE) value is between learning motivation and learning independence. The value of DE Learning motivation with learning independence is 0.78. This is in line with research showing that motivation affects students' learning independence (Moh Ghoizi Eriyanto et al., 2021).

Independent learning with learning achievement

When viewed from learning achievement, the most significant variable is learning independence (0.49). Independent learning will affect students' habits in education. Students can determine when, where, and how the learning process will occur. This ability makes it easier for students to master the concepts given. Their learning achievement is also higher for students with high learning independence (Mulyono, 2017).

Learning motivation with learning achievement

Motivation and learning style also affect achievement, although less than independent learning. Learning styles significantly affect learning achievement because learning styles affect a person's way of thinking (Baltaci et al., 2016). However, in the results of this study, gender did not directly affect student achievement. It was also found that gender did not significantly affect students' academic performance (Palomares-Ruiz et al., 2021).

If attention is focused on learning achievement, based on table 2, it is known that motivation has a greater influence than gender, learning style, and independent learning. This is because the total effect (TE) value in table 2 for motivation (0.71) is the highest when compared to the others. Several studies show that learning motivation influences mathematics learning achievement (Sinaga, 2022).

CONCLUSION AND IMPLICATION

Conclusion

Not all variables have a direct influence on each other. All variables influence learning achievement; this can directly or indirectly influence. Gender and learning styles affect learning motivation and independence, and learning independence involves learning achievement. Learning motivation has a greater influence than gender, learning style, and independent learning.

ACKNOWLEDGMENTS

REFERENCES

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology*, 84(3), 261–271. https://doi.org/10.1037/0022-0663.84.3.261

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, 103(3), 411–423. https://doi.org/10.1037/0033-2909.103.3.411

Arbuckle, J. L., & Wothke, W. (1995). *Amos 4.0 Users Guide*. SmallWaters Corporation.

Baltaci, S., Yildiz, A., & Özcakir, B. (2016). The Relationship between Metacognitive Awareness Levels, Learning Styles, Genders and Mathematics Grades of Fifth Graders. *Journal of Education and Learning*, 5(4), 78. https://doi.org/10.5539/jel.v5n4p78

Browne, M. W., & Cudeck, R. (1992). Alternative Ways of Assessing Model Fit. *Sociological Methods & Research*, 21(2), 230–258. https://doi.org/10.1177/0049124192021002005

Casey, B. M., & Ganley, C. M. (2021). An examination of gender differences in spatial skills and math attitudes in relation to mathematics success: A bio-psycho-social model. *Developmental Review*, 60(October 2020), 100963. https://doi.org/10.1016/j.dr.2021.100963

Demİr-Ayaz, A. (2022). A Path-Analytical Investigation of Perceptual Learning Styles , Future Self- guides and L2 Motivation A Path-Analytical Investigation of Perceptual Learning Styles , Future Self-guides and L2 Motivation. *Novitas-ROYAL (Research on Youth and Language),* 16(1), 1–19.

DePorter, B., & Hernacki, M. (1993). *Quantum Learning*. Judy Piatkus.

Eccles, J. S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology*, 61(xxxx), 101859. https://doi.org/10.1016/j.cedpsych.2020.101859

Felder, R. M., & Brent, R. (2005). Understanding Student Differences. *Journal of Engineering Education*, 94(1), 57–72. https://doi.org/10.1002/j.2168-9830.2005.tb00829.x

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to Design and Evaluate Research in Education (8th ed.)*. McGraw-Hill.

Harvey, V. S., & Chickie-Wolfe, L. A. (2007). *Fostering independent learning: practical strategies to promote student success. In Guilford Publications, Inc*. The Guilford Press.

Houston, K., & Lazenbatt, A. (1996). A Peer-tutoring Scheme to Support Independent Learning and Group Project Work in Mathematics. *Assessment & Evaluation in Higher Education*, 21(3), 251–266. https://doi.org/10.1080/0260293960210305

Kolb, D. A. (2015). *Experiential learning : experience as the source of learning and development (second)*. Pearson Education.

Middleton, J. A., & Spanias, P. A. (1999). Motivation for Achievement in Mathematics: Findings, Generalizations, and Criticisms of the Research. *Journal for Research in Mathematics Education*, 30(1), 65. https://doi.org/10.2307/749630

Moh Ghoizi Eriyanto, M.V. Roesminingsih, Soedjarwo, & Ivan Kusuma Soeherman. (2021). The Effect of Learning Motivation on Learning Independence and Learning Outcomes of Students in the Package C Equivalence Program. *IJORER : International Journal of Recent Educational Research*, 2(4), 455–467. https://doi.org/10.46245/ijorer.v2i4.122

Mulyono, D. (2017). The influence of learning model and learning independence on mathematics learning outcomes by controlling students' early ability. *International Electronic Journal of Mathematics Education*, 12(3), 689–708. https://doi.org/10.29333/iejme/642

Palomares-Ruiz, A., Cebrián-Martínez, A., García-Toledano, E., & López-Parra, E. (2021). Digital gender gap in university education in Spain. Study of a case for paired samples. *Technological Forecasting and Social Change*, 173, 121096. https://doi.org/10.1016/j.techfore.2021.121096

Pedhazur, E. J. (1997). *Multiple Regression in Behavioral Research (third).* Nelson Thomson Learning. https://doi.org/10.2307/2285468

Rose, C., & Nicholl, M. J. (1997). *Accelerated Learning For The 21st Century*. Dell Publishing.

Sinaga, S. J. (2022). The Effect of Motivation and Learning Style on Students' Mathematics Learning Achievement. *Jurnal Basicedu*, 6(3), 3554–3562. https://doi.org/10.31004/basicedu.v6i3.2669

Tanaka, M. (2022). Motivation, self-construal, and gender in project-based learning. *Innovation in Language Learning and Teaching*, 1–15. https://doi.org/10.1080/17501229.2022.2043870

Yudha, R. P. (2019). The Effect of Learning Approaches and Student Learning Styles on Mathematical Reasoning Abilities. *Eduma : Mathematics Education Learning and Teaching*, 8(2), 10. https://doi.org/10.24235/eduma.v8i2.5344

Yunus, A. S. M., & Wan Ali, W. Z. (2009). Motivation in the learning of mathematics. *European Journal of Social Sciences*, 7(4), 93–101.