EXPLORING THE DIRECT AND INDIRECT EFFECTS BETWEEN DEPENDENT AND INDEPENDENT VARIABLES USING PATH ANALYSIS

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Path Analysis- Meaning

Path analysis is a multivariate technique which provides possibilities for causal determinations among sets of measured variables. It is a technique using standardized multiple regression equations in examining a theoretical model. Using path analysis, it is possible to postulate the relationships, the extent of relationships and the direction of relationships. Hence, for a predictive extent of determination, path analysis was conceived and tested in the present study (Miller, 1991).

Theoretical Assumptions of Path Analysis

In simple, multiple and multivariate regression analysis, emphasis is on the study of the extent to which the dependent variable)s) get affected by the contribution of the independent variable(s) on original scales of measurement being standardized for compariso0n of the scores with the studies being carried out by others with the same variable(s). The regression coefficients obtained by carrying out simple, multiple or multivariate regression analysis are found to get affected by the unit of scale of measurement. In other words the values of the regression coefficients of the variables get altered with the change of unit of measurement of the variable(s). In order to understand the true relation between the dependent and independent variables it becomes necessary to have regression coefficients independent of the unit of measurement of the variables. This is achieved by both the dependent and the independent variables being standardized as : $Z=X-\mu$ / with μ and being the mean and the standard deviation of the variable X: It is evident that the

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standardized variable Z has mean zero (0) and variance one (1) (Garrett 1981, p. 313). With the standardized variables, the regression coefficients will be having the same value as that of the corresponding correlation coefficients. The regression coefficients are directional in the cause of the corresponding dependent variable.

Thus, the regression coefficient in the regression models of the standardized variables, have come to be named as path (directional) coefficients, with the path (direction) being from an independent variable towards the corresponding dependent variable. Hence, the regression analysis carried out with the help of standardized variables has come to be known as path analysis. It is worth noting that, the values of the path coefficients as regression coefficients of standardized variables, are the same in their values as those of the corresponding correlation coefficients. In magnitude, the correlation coefficients are the same as the path coefficients but path coefficients are directional while the correlation coefficients are not directional, though both are independent of the units of measurement of the corresponding variables.

Added advantage of path analysis over multiple linear regression analysis is that of finding the direct and indirect effects of the independent variables on the corresponding dependent variable. In general, a variable can have its effect on a dependent variable with the effect being revealed by the magnitude and the direction of the path coefficient of the independent variable.

Path Analysis (Multiple) : An Illustration

Path analysis consists of five steps of computation: 1. Develop a path model; 2. Establish a pattern of association; 3. Calculate path coefficient; 4. Interpret the results; 5. Depict a path diagram.

In order to verify the influence of key variables on mathematics performance of students, path coefficients were computed and the path diagrams were depicted. The conventions framed by Land (1969) and earlier Duncan (1966) were adopted in constructing the path diagrams for the present study. They were as follows "We present assumed causal relations or path between variables by unidirectional (one head) straight arrows that connect each independent variable to each variable dependent on it."

The statistical analysis in examining the fitness of the basic path model developed comprises two stages. In the first stage simple correlation between the selected variables and Achievement in Science are computed. This is followed by computing path coefficients in the second stage.

As the present illustration has attempted to show the direct and indirect effects between Achievement in Science and intelligence among secondary school students.

Hypothesis: There is no significant direct and indirect effect of Science process skill and Intelligence on pre-test achievement in science of secondary school students.

To achieve this hypothesis, the linear multiple regression analysis was applied and the results are presented in the following table.

Table-1:The Direct and Indirect Path Coefficients of Independent Variables i.e., Science Process Skill and Intelligence on Pre-test Achievement in Science of Secondary School Students
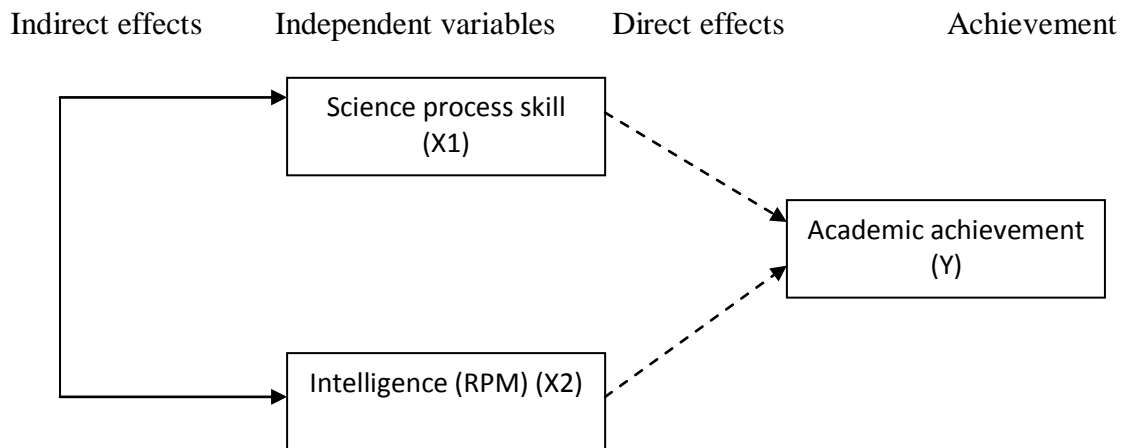
Dependent variable	Independent variables	Direct effects	Indirect effects through	
			X1	X2
Achievement in science	Science process skill (X1)	0.1826	-	0.2547*
	Intelligence (X2)	0.0161	0.3209*	-

* Indicates significant at 0.05 level of significance

The results of the above table reveal that,

1. The direct effect of Science process skill (X1) on pre-test achievement in Science of secondary school students is found to be positive and not significant. It means that, the Science process skill (X1) of secondary school students is not directly effects on pre-test achievement in Science of secondary school students.

2. The direct effect of Intelligence (X2) on pre-test achievement in Science of secondary school students is found to be positive and not significant. It means that, the Intelligence (X2) of secondary school students is not directly effects on pre-test achievement in Science of secondary school students. The significant direct and indirect effects of independent variables on achievement are presented in the following diagram.

Figure-1:The Direct and Indirect Path Coefficients of Independent Variables i.e., Science Process Skill and Intelligence on Pre-test Achievement in Science of Secondary School Students

Hypothesis: There is no significant direct and indirect effect of Science process skill and Intelligence on post-test achievement in Science of secondary school students.

To achieve this hypothesis, the linear multiple regression analysis was applied and the results are presented in the following table.

Table-2:The Direct and Indirect Path Coefficients of Independent Variables i.e., Science Process Skill and Intelligence on Post-test Achievement in Science of Secondary School Students

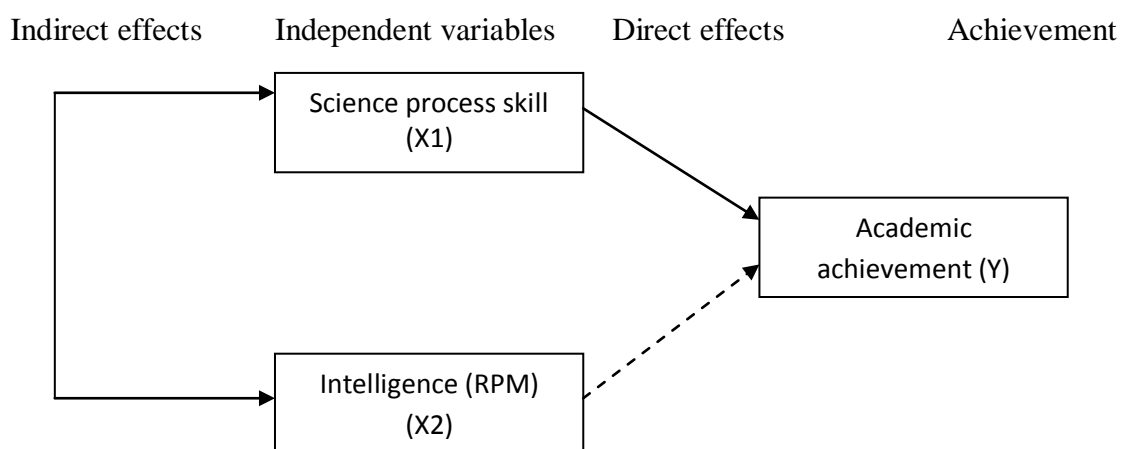| Dependent variable	Independent variables	Direct effects	Indirect effects through	
			X1	X2
Achievement in science	Science process skill (X1)	0.6359*	-	0.2547*
	Intelligence (X2)	0.1997	0.3209*	-

* Indicates significant at 0.05 level of significance

The results of the above table reveal that,

- The direct effect of Science process skill (X1) on post-test achievement in Science of secondary school students is found to be positive and significant. It means that, the Science process skill (X1) of secondary school students is directly effects on post-test achievement in Science of secondary school students.

- The direct effect of Intelligence (X2) on post-test achievement in Science of secondary school students is found to be positive and not significant. It means that, the Intelligence (X2) of secondary school students is not directly effects on post-test achievement in Science of secondary school students. The significant direct and indirect effects of independent variables on achievement are presented in the following diagram.

Figure-2:The Direct and Indirect Path Coefficients of Independent Variables i.e., Science Process Skill and Intelligence on Post-test Achievement in Science of Secondary School Students

Conclusion

Path analysis with all the variables being standardized has provided clear picture of direct and indirect effects of independent variables on dependent variables. The corresponding regression analysis gets masked due to the dependent and independent variables not being standardized. Moreover, in the case of regression analysis it is not possible to know the extent of indirect effect of a variable on another variable through a third variable. Hence, the importance of multiple and multivariate path analysis over multiple and multivariate regression analysis. Moreover, path analysis provides basic for comparison of findings of similar studies.

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