EFFECT OF THE DEMOGRAPHIC CHARACTERISTICS ON STUDENTS’ ACHIEVEMENT-
A PATH ANALYTIC STUDY

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ABSTRACT

Primary purpose of this study is to examine the influence of the demographic characteristics and the relationships between these characteristics on the students’ achievement with path analysis. First of all the affects of the demographic characteristics to the elementary school diploma grades of the students and later the affects of the elementary school diploma grade together with the demographic characteristics have been examined. In the result of the examinations made with the path analysis; while it’s being determined that the education level of the father and gender variables among the demographic characteristics did not have an affect over the physics achievement that the students achieved from this study however the education level of the mother and the income level of the family had a positive effect on the elementary school achievement grades of the student.

Key Words: Field education, path analysis, demographic characteristics, achievement.

INTRODUCTION

Researches have conducted regarding to the achievement reveal that the families’ education levels are an important factor in estimating the students’ achievement (Klebanov, Brooks- Gunn, & Duncan, 1994; Haveman & Wolfe, 1995; Smith, Brooks-Gunn, & Lebanov, 1997). Certain studies that have been done on this subject reveal that the families’ education levels affect in positive direction both their behaviors and beliefs towards raising their children (Eccles, 1993) and children’ achievements and learning experiences (Jimerson, Egeland, & Teo, 1999; Kohn, 1963; Luster, Rhoades, & Haas, 1989). It has been also determined by Alexander, Entwisle, and Bedinger (1994) that the families with higher education and income levels have been paying more attention to daily performances of their children in comparison with the families with lower education and income levels. Along with that, Halle and friends (1997) have determined that as the mother’s education level increasing with expectations of the children regarding academic achievement also increases and further determined that this has been as much influential as perceptions that the children have had and as a result of this, the children’ achievements have increased in mathematics and reading lessons, in a study they have performed over low income families. Certain researchers have stated that the families’ education level’s increase, especially of the mother, forms a warmer social environment in home atmosphere and both the mother’s education level and income level has a significant impact on the learning activities’ determination at home and in physical environments; however, warm relationship between the families and children on the other hand is only provided by the mother (Klebanov et al. 1994). In a similar form, Smith and friends (1997) have indicated that increase in the student achievement that is connected to the family’s income level and the families’ education is influenced by the home environment and the mother’s involvement in this achievement that the students reveal on the other hand is more effective than the income level. Another factor stated to be effective in the student’s achievement that the families’ education level sand, which is also main foundation in
the constructive learning, is an initial knowledge that the students have had. The factors such as age, gender, and Department’s line of preference that he/she studies, working part-time or full-time at a workplace, attitude and self-efficacy that has an impact on the student’s achievement have been examined with the path analysis in a study conducted by Zeegers (2004) concerning this subject. For that purpose, a study has been conducted by working with two groups of students, who have been receiving an education in the science department of Flinders University and 194 of these students are freshmen and 118 of them are sophomore. And, it has been determined as a result of the study that the achievement coming from the students’ previous education has increased their achievements and learning English abilities in the university.

The gender factor’s effectiveness that remains outside of the families’ education levels and initial knowledge that the students have been also examined in this study due to the fact that whether or not the gender factor have had any effects over the students’ achievement or topic of many studies (Zeeger, 2004; Jones, Howe & Rua, 2000). As it has been informed about the gender factor having an impact on the student’s achievement in the studies conducted over the gender factor (Lietz, 1996), it is also being informed that the gender factor does not have a significant impact over the students’ achievement (Author, 2008; Zeegers, 2004; Murray-Harvey 1993).

The path analysis technique, which is an application field of structural equation model, has been used while the demographic characteristics’ influences discussed on the students’ physics achievement are being examined in this study’s scope. Since it is necessary to tackle both observable and unobservable impacts to be able to make healthier comments in the path analysis, interaction between the variables has been examined by considering both the observable and unobservable (IE, UE, SE) impacts in this study and this is what makes this research different from the similar researches.

**Problem status**

While the student achievement is being measured in field education studies, results and comments, which are going to be achieved with considering the demographic characteristics’ effects and unobservable effects, that these characteristics have achieved over one another are going to contribute for us to present more permanent solutions instead of using only a single variable (for example: teaching method).

**Aim**

The primary aim of this study is to examine the factors that affect the student achievement with the path analysis technique by not only considering the factors in the foundation of instruction method but also considering the other factors (The mother’s education level, family’s income level, gender, the father’s education level and elementary school diploma grade) at the same time.

**METHOD**

**Population and Sample**

This study’s population is formed by the high school students, who have been receiving an education in the city center of Diyarbakir in the academic year of 2006-2007 and this study’s sample on the other hand is formed by 167 students, who have been receiving an education in the schools where application is administered in the study’s scope.

**Application Process**

The study has been conducted over 167 students, who receive 2nd and 3rd grade education in four different high schools found in the city center of Diyarbakir in the academic year of 2006-2007. A science high school, a anatolian high school, a occupational high school and a general high school have been determined as the schools that are going to be studied in the research’s scope. Two groups have been formed in each of the specified school. An electrostatic achievement test that has been formed with 30 multiple-chosen questions
and a demographic characteristics’ survey has been formed 8 questions that have been applied to the each group formed. The analyses performed however, have been done by only considering 5 of the demographic characteristics in this study. Random selection has been made about which the instruction method would be applied on which group. The instruction method to one of the students’ group has been applied according to CACL model and the other student group has been applied according to CA7E model.

The data in this study conducted has been analyzed by using the SPSS 15.0 and Amos 7.0 package programs for the values Path coefficients (standardized regression coefficients) that have been obtained as a result of the analysis performed with the SPSS 15.0 and Amos 7.0 package programs and they have been shown directly on the path diagram and only the correlation coefficients and results of path analysis have been shown in form of tables.

**Interactions Seen Between the Variables and Variables Types**

There are for different effects among the variables that have been subjected to the path analysis and these are indicated as observable effect (DE), unobservable effect (IE), Unanalyzed effect (U), and Spurious effect (S). to get detailed information about those effect, please look at the Author (2008).

**Interpretation and Analysis of the Data**

The data obtained from this study have been tackled on the basis of two different learning approaches (CACL and CA7E) and two different path analyses have been performed for the examined demographic characteristics’ effects for the student achievement. Therefore, besides the demographic characteristics’ effect, the effectiveness level of the teaching approaches has also been researched.

In the path analysis, in order for the relationships to be fully analyzed; it is necessary to keep in mind all the reason variables and result variables and all the relationships of the reason variables among themselves and even the existence of a significant relationship between the variables. In order for the interpretation of all conditions creating difference on the result variables and rising from the applied learning approaches together with the demographic characteristics and the statistical results as a whole here a different method has been suggested and a different route of evaluation has been taken. The fundamental steps of this evaluation method which has been suggested by Author (2008) are as follow:

1. Consistencies in the relationships that the same variables had with one another in each of the two teaching methods have been considered (For example: the gender variable in the CACL and CA7E).  
2. If the relationship between two of the same variables analyzed in each two of the learning approaches and result variable is statistically significant, the consistency coefficient has been accepted as “1”.  
3. If the relationship between the result variable and only one of two of the same variables analyzed in each two of the learning approaches is statistically significant, the consistency coefficient has been accepted as “0.5”.  
4. If there is no statistical significance between the result variable and the two of the same variables analyzed in each two of the learning approaches, the consistency coefficient has been accepted as “0”.  
5. The variables effect with the consistency coefficient “1” on the result variable has been accepted as directly significant.  
6. The variables with the consistency coefficient of “0.5” have been interpreted by looking at the percentage in the total effect of the DE effects of their both.  
7. The variables with the consistency coefficient of “0” have been accepted as having no effect on the result variable. 

\((X_mY_n, m, n=1, 2, 3,...)\): has been defined as the consistency coefficient between the X reason variable and Y result variable.
FINDINGS

In this section, at first stage, the parent’s education levels effects, gender and the family income status to the student’s elementary school diploma grade have been analyzed with the approaches of CACL and CA7E. In the second stage on the other hand, the parent’s education levels’ effects, gender, family income status and the student’s elementary school diploma grade onto the achievements connected to the subject of the student’s electrostatic has been analyzed.

At the end of the study, it has been determined from the results obtained from the t-tests of the groups that have been coupled in order to determine the learning approach’s effect on the student achievement; both CACL ($t=6.172$ and $P<0.001$) and CA7E ($t=6.852$ and $P<0.001$) contributed positively and significantly to the students’ achievement. Also, the demographic characteristics’ analysis remain outside of the learning approaches in the achievement that the student shown on the other hand has been performed with the path analysis. The path diagram showing the relationships between the variables used during the analysis of the data has been given in Figure 1. $P_{XY}$ among the symbols taking place in the Figure 1 shows the path coefficient between the variables and $r_{XY}$ on the other hand shows the correlation coefficient between the variables.

![Path Diagram Showing the Relationships between the Variables](image)

**Figure 1:** Path Diagram Showing the Relationships between the Variables

$X_1$: Mother’s education level, $X_2$: Family’s income level, $X_3$: Gender, $X_4$: Father’s education level, $Y_1$: Elementary school diploma grade, $Y_2$: Score obtained from the achievement test, $e_1$ and $e_2$: Unobservable external variables.

At the end of the regression analysis performed the path coefficients (standardized regression coefficients) between all the variables have been shown in the diagram in Figure 2. The values on the arrows located in the
diagram; the ones on the left side shows the path coefficients obtained from the data of the students who received education with CACL and the ones on the right side shows the path coefficients obtained from the data of the students who received education with CA7E (For example; such as 111 & 222).

Since the path analysis’s main purpose is to separate the components of the correlation between the variables, it is necessary for us to know the correlation coefficient between all the variable pairs. Correlation coefficients between all the variables inside the study have been given in Table 1. In the correlation coefficients found in Table 1 there are 2 columns for each variable. Left column shows the correlation coefficients found according to the data of the students receiving education with CACL and right column shown the correlation coefficient obtained from the data of the students receiving education with CA7E.

Figure 2: Path Diagram and Coefficients of the Model Established for the CACL & CA7E Approaches.
Table 1: Correlation Matrix

<table>
<thead>
<tr>
<th>Variables</th>
<th>X₁</th>
<th>X₂</th>
<th>X₃</th>
<th>X₄</th>
<th>Y₁</th>
<th>Y₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Corr.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>90</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Corr.</td>
<td>0.518**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>90</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Corr.</td>
<td>0.315**</td>
<td>0.261*</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.001</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>90</td>
<td>77</td>
<td>90</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Corr.</td>
<td>0.274</td>
<td>0.033</td>
<td>0.022</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.058</td>
<td>0.001</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>90</td>
<td>77</td>
<td>90</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Corr.</td>
<td>0.473**</td>
<td>0.411**</td>
<td>0.199</td>
<td>0.294**</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>90</td>
<td>77</td>
<td>90</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Corr.</td>
<td>0.217*</td>
<td>0.242**</td>
<td>0.271**</td>
<td>0.306**</td>
<td>0.057</td>
<td>0.066</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.040</td>
<td>0.034</td>
<td>0.010</td>
<td>0.007</td>
<td>0.095</td>
<td>0.069</td>
</tr>
<tr>
<td>N</td>
<td>90</td>
<td>77</td>
<td>90</td>
<td>77</td>
<td>90</td>
<td>77</td>
</tr>
<tr>
<td>Pearson Corr.</td>
<td>0.030</td>
<td>0.040</td>
<td>0.079</td>
<td>0.111</td>
<td>0.273**</td>
<td>0.081</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.079</td>
<td>0.046</td>
<td>0.035</td>
<td>0.009</td>
<td>0.483</td>
<td>0.585</td>
</tr>
<tr>
<td>N</td>
<td>90</td>
<td>77</td>
<td>90</td>
<td>77</td>
<td>90</td>
<td>77</td>
</tr>
</tbody>
</table>

*P<0.05, **P<0.01

Separating the Components of the Correlations between the Demographic Variables Affecting the Physics Achievement in the Path Model Established for the CACL Approach

Analyses Concerning with the Effects of the Demographic Characteristics to the Achievement in the Computer Aided CACL

When the correlations between the variables are separated into components and if the correlation between the X₁ and Y₂ is written by separating the components as it is seen below,

\[
\begin{pmatrix}
  r_{y_1x_1} \\
  r_{y_1x_2} \\
  r_{y_1x_3} \\
  r_{y_1x_4}
\end{pmatrix} = \begin{pmatrix}
  P_{y_1x_1} r_{x_1x_1} \\
  P_{y_1x_2} r_{x_2x_1} + P_{y_1x_2} r_{x_2x_2} \\
  P_{y_1x_3} r_{x_3x_1} + P_{y_1x_3} r_{x_3x_2} + P_{y_1x_3} r_{x_3x_3} \\
  P_{y_1x_4} r_{x_4x_1} + P_{y_1x_4} r_{x_4x_2} + P_{y_1x_4} r_{x_4x_3} + P_{y_1x_4} r_{x_4x_4}
\end{pmatrix}
\]

(3.1)

\[
\begin{pmatrix}
  r_{y_2x_1} \\
  r_{y_2x_2} \\
  r_{y_2x_3} \\
  r_{y_2x_4}
\end{pmatrix} = \begin{pmatrix}
  P_{y_2x_1} r_{x_1x_1} \\
  P_{y_2x_1} r_{x_1x_2} + P_{y_2x_1} r_{x_1x_3} + P_{y_2x_1} r_{x_1x_4} \\
  P_{y_2x_2} r_{x_2x_1} + P_{y_2x_2} r_{x_2x_2} + P_{y_2x_2} r_{x_2x_3} + P_{y_2x_2} r_{x_2x_4} \\
  P_{y_2x_3} r_{x_3x_1} + P_{y_2x_3} r_{x_3x_2} + P_{y_2x_3} r_{x_3x_3} + P_{y_2x_3} r_{x_3x_4}
\end{pmatrix}
\]

(3.2)

It is found such as shown.

In order for this expression to be written in a clear form, it is necessary to state the expansions of the \( r_{x_1x_1} \), \( r_{x_2x_1} \), \( r_{x_3x_1} \) and \( r_{x_4x_1} \). Since the \( r_{x_1x_1} \), \( r_{x_2x_1} \), \( r_{x_3x_1} \) and \( r_{x_4x_1} \) are the correlations between the exogenous variables, their values given in the Table 1 is used exactly. However, due to the fact that the Y₁ variable is an
endogenous variable it is necessary for \( r_{xy} \) to be turned into the matrix form as it is in \( r_{yx} \). When the \( r_{xy} \) is written in the matrix form and the necessary operations are performed \( r_{yx} \),

\[
\begin{pmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1 \\
\end{pmatrix}
\]

it is found such as this.

When the correlation between the \( X_1 \) and \( Y_2 \) is separated into its components,

\[
r_{yx_1} = P_{y_1x_1} r_{x_1y_1} + P_{y_2x_2} r_{x_2y_2} + P_{y_3x_3} r_{x_3y_3} + P_{y_4x_4} r_{x_4y_4}
\]

it is found as shown.

In the analysis above, all the effects of the \( X_1 \) over the \( Y_2 \) has been shown in Table 2.

Table 2: DE, IE, S and U Effects of the Mother’s Education Level the Achievement Test

<table>
<thead>
<tr>
<th>( P_{ij} )</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P_{y_1x_1} r_{xy} )</td>
<td>DE</td>
<td>-0.045</td>
<td>-149</td>
</tr>
<tr>
<td>( P_{y_2x_2} r_{xy} )</td>
<td>U</td>
<td>-0.031</td>
<td>-102</td>
</tr>
<tr>
<td>( P_{y_3x_3} r_{xy} )</td>
<td>U</td>
<td>0.060</td>
<td>198</td>
</tr>
<tr>
<td>( P_{y_4x_4} r_{xy} )</td>
<td>U</td>
<td>-0.043</td>
<td>-143</td>
</tr>
<tr>
<td>( P_{y_1x_1} P_{y_2x_2} r_{xy} )</td>
<td>IE</td>
<td>0.068</td>
<td>225</td>
</tr>
<tr>
<td>( P_{y_1x_1} P_{y_3x_3} r_{xy} )</td>
<td>U</td>
<td>0.047</td>
<td>157</td>
</tr>
<tr>
<td>( P_{y_1x_1} P_{y_4x_4} r_{xy} )</td>
<td>U</td>
<td>-0.003</td>
<td>-9</td>
</tr>
<tr>
<td>( P_{y_2x_2} P_{y_3x_3} r_{xy} )</td>
<td>U</td>
<td>-0.023</td>
<td>-77</td>
</tr>
<tr>
<td>Total ( r_{xy} )</td>
<td></td>
<td>0.030</td>
<td>100</td>
</tr>
</tbody>
</table>

When the correlation between the \( X_1 \) and \( Y_2 \) is separated into its components as it is seen below,

\[
r_{yx_1} = P_{y_1x_1} r_{x_1y_1} + P_{y_2x_2} r_{x_2y_2} + P_{y_3x_3} r_{x_3y_3} + P_{y_4x_4} r_{x_4y_4}
\]
In the analysis above, all effects of the \( X_2 \) on \( Y_2 \) has been shown in Table 3.

Table 3: DE, IE, S and U Effects of the Mother’s Education Level on the Elementary School Grade

<table>
<thead>
<tr>
<th>( P_{ij} )</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P_{Y_1X_1} r_{Y_1Y_1} )</td>
<td>DE</td>
<td>0.166</td>
<td>76</td>
</tr>
<tr>
<td>( P_{Y_1X_2} r_{Y_1Y_1} )</td>
<td>U</td>
<td>0.115</td>
<td>53</td>
</tr>
<tr>
<td>( P_{Y_1X_3} r_{Y_1Y_1} )</td>
<td>U</td>
<td>-0.007</td>
<td>-3</td>
</tr>
<tr>
<td>( P_{Y_1X_4} r_{Y_1Y_1} )</td>
<td>U</td>
<td>-0.057</td>
<td>-26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>0.217</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Correlation between \( X_2 \) and \( Y_2 \), \( r_{Y_2Y_2} \), is separated into its components in the form shown below.

When the \( r_{Y_2Y_2} \) is written as below,

\[
\begin{bmatrix}
    r_{Y_2Y_2} \\
    r_{X_2Y_2} \\
    r_{X_2X_2} \\
    r_{Y_2Y_2} \\
\end{bmatrix} =
\begin{bmatrix}
    P_{Y_2X_1} & P_{Y_2X_2} & P_{Y_2X_3} & P_{Y_2X_4} & P_{Y_2Y_1} \\
\end{bmatrix}
\begin{bmatrix}
    r_{Y_1Y_1} \\
    r_{X_1Y_1} \\
    r_{X_1X_1} \\
    r_{Y_1Y_1} \\
\end{bmatrix}
\]

(3.10)

\[
r_{Y_2Y_2} = P_{Y_2X_1} r_{X_1Y_2} + P_{Y_2X_2} r_{X_2Y_2} + P_{Y_2X_3} r_{X_3Y_2} + P_{Y_2X_4} r_{X_4Y_2} + P_{Y_2Y_1} r_{Y_1Y_2}
\]

(3.11)

It is found as expressed above.

In order for this expression to be written in a clear form, it is necessary to state the expansions

of \( r_{X_2Y_2} \), \( r_{X_2X_2} \), \( r_{X_2X_2} \), \( r_{X_2X_2} \), and \( r_{Y_1Y_2} \). Since the \( r_{X_2Y_2} \), \( r_{X_2X_2} \), \( r_{X_2X_2} \), and \( r_{X_2X_2} \) are the correlations between the exogenous variables the values given in the Table 1 for them are used exactly. However, due to the fact that the \( Y_1 \) variable is an endogenous variable it is necessary for \( r_{Y_1Y_2} \) to be turned into the matrix form as it is in \( r_{Y_2Y_2} \). When the \( r_{Y_1Y_2} \) is written in the matrix form and the necessary operations are performed \( r_{Y_1Y_2} \),

\[
\begin{bmatrix}
    r_{Y_1Y_1} \\
    r_{X_1Y_1} \\
    r_{X_1X_1} \\
\end{bmatrix} =
\begin{bmatrix}
    P_{Y_1X_1} & P_{Y_1X_2} & P_{Y_1X_3} & P_{Y_1X_4} \\
\end{bmatrix}
\begin{bmatrix}
    r_{Y_2Y_2} \\
    r_{X_2Y_2} \\
    r_{X_2X_2} \\
\end{bmatrix}
\]

(3.12)

\[
r_{Y_1Y_1} = P_{Y_1X_1} r_{X_1Y_1} + P_{Y_1X_2} r_{X_2Y_1} + P_{Y_1X_3} r_{X_3Y_1} + P_{Y_1X_4} r_{X_4Y_1}
\]

(3.13)

is found as it is shown above.
When the $X_2$ and $Y_2$ are separated into their components,

$$r_{2y_2} = P_i x_1 r_{x_2 y_3} + P_i x_2 r_{x_2 y_2} + P_i x_3 r_{x_2 y_2} + P_i x_4 r_{x_2 y_2} + P_i y_1 x_1 r_{y_1 x_2 y_2} + P_i y_2 x_2 r_{y_2 x_2 y_2} + P_i x_3 r_{x_2 y_2} + P_i x_4 r_{x_2 y_2} \quad (3.14)$$

$$r_{3y_2} = P_i x_1 r_{x_3 y_2} + P_i x_2 r_{x_3 y_2} + P_i x_3 r_{x_3 y_2} + P_i y_1 x_1 r_{y_1 x_3 y_2} + P_i y_2 x_2 r_{y_2 x_3 y_2} + P_i y_3 x_3 r_{y_3 x_3 y_2} + P_i y_4 x_4 r_{y_4 x_3 y_2} + P_i y_5 x_5 r_{y_5 x_3 y_2} + P_i y_6 x_6 r_{y_6 x_3 y_2} \quad (3.15)$$

$$r_{3y_2} = 0.079 \quad (3.16)$$

found as it is shown above.

All effects of the $X_2$ on $Y_2$ are shown in the Table 4.

**Table 4: DE, IE, S and U Effects of the Family’s Income Level on the Achievement Test**

<table>
<thead>
<tr>
<th>$P_{ij}$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_i x_1 r_{x_2 y_2}$</td>
<td>U</td>
<td>-0.02</td>
<td>-25</td>
</tr>
<tr>
<td>$P_i x_2 r_{x_2 y_2}$</td>
<td>DE</td>
<td>-0.068</td>
<td>-86</td>
</tr>
<tr>
<td>$P_i x_3 r_{x_2 y_2}$</td>
<td>U</td>
<td>0.094</td>
<td>118</td>
</tr>
<tr>
<td>$P_i x_4 r_{x_2 y_2}$</td>
<td>U</td>
<td>-0.037</td>
<td>-47</td>
</tr>
<tr>
<td>$P_i x_1 r_{x_3 y_2}$</td>
<td>U</td>
<td>0.030</td>
<td>38</td>
</tr>
<tr>
<td>$P_i y_1 x_1 r_{y_1 x_3 y_2}$</td>
<td>IE</td>
<td>0.104</td>
<td>132</td>
</tr>
<tr>
<td>$P_i y_2 x_2 r_{y_2 x_3 y_2}$</td>
<td>U</td>
<td>-0.004</td>
<td>-05</td>
</tr>
<tr>
<td>$P_i y_3 x_3 r_{y_3 x_3 y_2}$</td>
<td>U</td>
<td>-0.02</td>
<td>-25</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>0.079</td>
<td>100</td>
</tr>
</tbody>
</table>

When the correlation between the $X_2$ and $Y_1$ is separated into its components,

$$r_{1y_1} = P_i x_1 r_{x_1 y_1} + P_i x_2 r_{x_2 y_1} + P_i x_3 r_{x_2 y_1} + P_i x_4 r_{x_2 y_1} \quad (3.17)$$

$$r_{1y_1} = 0.271 \quad (3.18)$$

is found as it is shown above.

In the analysis above, all effects of the $X_2$ on the $Y_1$ is shown in Table 5.

**Table 5: DE, IE, S and U Effects of the Family’s Income Level on the Elementary School Diploma Grade.**

<table>
<thead>
<tr>
<th>$P_{ij}$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_i x_1 r_{x_2 y_2}$</td>
<td>U</td>
<td>0.075</td>
<td>27</td>
</tr>
<tr>
<td>$P_i x_2 r_{x_2 y_2}$</td>
<td>DE</td>
<td>0.256</td>
<td>94</td>
</tr>
<tr>
<td>$P_i x_3 r_{x_2 y_2}$</td>
<td>U</td>
<td>-0.010</td>
<td>-3</td>
</tr>
<tr>
<td>$P_i x_4 r_{x_2 y_2}$</td>
<td>U</td>
<td>-0.050</td>
<td>-18</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>0.271</td>
<td>100</td>
</tr>
</tbody>
</table>
Correlation ($r_{y_2x_3}$) between the $X_3$ and the $Y_2$ is separated into its components as it is shown below.

When the ($r_{y_2x_3}$) is written as below,

$$r_{y_2x_3} = \begin{bmatrix} r_{x_1x_3} \\ r_{x_2x_3} \\ r_{x_3x_3} \\ r_{x_4x_3} \\ r_{y_1x_3} \end{bmatrix} = \begin{bmatrix} r_{x_1x_3} \\ r_{x_2x_3} \\ r_{x_3x_3} \\ r_{x_4x_3} \\ r_{y_1x_3} \end{bmatrix} = \begin{bmatrix} P_{y_2|x_3} P_{y_2|x_2} P_{y_2|x_1} P_{y_2|x_1} \end{bmatrix}$$

(3.19)

(3.20)

It is found as it is shown above.

In order for this expression to be written in a clear form, it is necessary to state the expansions of $r_{x_1x_3}$, $r_{x_2x_3}$, $r_{x_3x_3}$, and $r_{x_4x_3}$. Since the $r_{x_1x_3}$, $r_{x_2x_3}$, $r_{x_3x_3}$, and $r_{x_4x_3}$ are the correlations between the exogenous variables, the values given in the Table 1 for them are used exactly. However, due to the fact that the $Y_1$ variable is an endogenous variable it is necessary for $r_{y_1x_3}$ to be turned into the matrix form as it is in $r_{y_2x_3}$.

When the $r_{y_1x_3}$ is written in the matrix form and the necessary operations are performed $r_{y_1x_3}$,

$$r_{y_1x_3} = \begin{bmatrix} r_{x_1x_3} \\ r_{x_2x_3} \\ r_{x_3x_3} \\ r_{x_4x_3} \\ r_{y_1x_3} \end{bmatrix} = \begin{bmatrix} P_{y_1|x_3} P_{y_1|x_2} P_{y_1|x_1} P_{y_1|x_4} \end{bmatrix}$$

(3.21)

(3.22)

found as it is shown above.

When the correlation between the $X_3$ and the $Y_2$ is separated into its components,

$$r_{y_2x_3} = P_{y_2|x_3} r_{x_1x_3} + P_{y_2|x_3} r_{x_2x_3} + P_{y_2|x_3} r_{x_3x_3} + P_{y_2|x_3} r_{x_4x_3} + P_{y_2|x_3} (P_{y_2|x_3} r_{x_3x_3} + P_{y_2|x_3} r_{y_2x_3})$$

(3.23)

$$r_{y_2x_3} = P_{y_2|x_3} r_{x_1x_3} + P_{y_2|x_3} r_{x_2x_3} + P_{y_2|x_3} r_{x_3x_3} + P_{y_2|x_3} r_{x_4x_3} + P_{y_2|x_3} r_{y_2x_3} + P_{y_2|x_3} r_{y_2x_3} + P_{y_2|x_3} r_{x_3x_3} + P_{y_2|x_3} r_{x_4x_3}$$

(3.24)

$$r_{y_2x_3} = 0.273681$$

(3.25)

It is found as it is expressed above.

All effects of the $X_3$ on the $Y_2$ have been shown in the Table 6.
Table 6: DE, IE, S and U Effects of the Gender on the Achievement Test.

<table>
<thead>
<tr>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{Y_2X_1} r_{x_{3x_1}}$</td>
<td>-0,009</td>
<td>-3</td>
</tr>
<tr>
<td>$P_{Y_2X_2} r_{x_{3x_2}}$</td>
<td>-0,02142</td>
<td>-8</td>
</tr>
<tr>
<td>$P_{Y_3X_3} r_{x_{3x_3}}$</td>
<td>0,299</td>
<td>109</td>
</tr>
<tr>
<td>$P_{Y_4X_4} r_{x_{3x_3}}$</td>
<td>-0,01881</td>
<td>-7</td>
</tr>
<tr>
<td>$P_{Y_4X_4} P_{X_2X_2} r_{x_{3x_3}}$</td>
<td>0,013579</td>
<td>5</td>
</tr>
<tr>
<td>$P_{Y_4X_4} P_{X_3X_3} r_{x_{3x_3}}$</td>
<td>0,032982</td>
<td>12</td>
</tr>
<tr>
<td>$P_{Y_4X_4} P_{X_3X_3} r_{x_{3x_3}}$</td>
<td>-0,0135</td>
<td>-5</td>
</tr>
<tr>
<td>$P_{Y_4X_4} r_{x_{3x_3}}$</td>
<td>-0,00985</td>
<td>-3</td>
</tr>
<tr>
<td>Total</td>
<td>$r_{y_{3x_3}}$</td>
<td>0,273681</td>
</tr>
</tbody>
</table>

When the correlation between $X_3$ and $Y_1$ is separated into its components,

$$r_{y_{3x_3}} = P_{Y_2X_1} r_{x_{3x_1}} + P_{Y_2X_2} r_{x_{3x_2}} + P_{Y_3X_3} r_{x_{3x_3}} + P_{Y_4X_4} r_{x_{3x_3}}$$

(3.26)

$$r_{y_{3x_3}} = 0,057$$

(3.27)

It is found as it is shown above.

Table 7: DE, IE, S and U Effects of the Gender on the Elementary School Diploma Grade

<table>
<thead>
<tr>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{Y_2X_1} r_{x_{3x_1}}$</td>
<td>0,033</td>
<td>58</td>
</tr>
<tr>
<td>$P_{Y_2X_2} r_{x_{3x_2}}$</td>
<td>0,081</td>
<td>142</td>
</tr>
<tr>
<td>$P_{Y_3X_3} r_{x_{3x_3}}$</td>
<td>-0,033</td>
<td>-58</td>
</tr>
<tr>
<td>$P_{Y_4X_4} r_{x_{3x_3}}$</td>
<td>-0,024</td>
<td>-42</td>
</tr>
<tr>
<td>Total</td>
<td>$r_{y_{3x_3}}$</td>
<td>0,057</td>
</tr>
</tbody>
</table>

Correlation ($r_{y_{3x_4}}$) between the $X_4$ and $Y_2$ is separated into its components as it is shown below.

When $r_{y_{3x_4}}$ is written as below,
\[ r_{y2x4} = \left[ P_{y2x1} P_{y2x2} P_{y2x3} P_{y2x4} P_{y2y1} \right] \]

\[ r_{y2x4} = P_{y2x1} r_{x1y4} + P_{y2x2} r_{x2y4} + P_{y2x3} r_{x3y4} + P_{y2x4} r_{x4y4} + P_{y2y1} r_{y1y4} \]  \hspace{1cm} (3.28)

\[ r_{y2x4} = P_{y2x1} r_{x1y4} + P_{y2x2} r_{x2y4} + P_{y2x3} r_{x3y4} + P_{y2x4} r_{x4y4} + P_{y2y1} r_{y1y4} \]  \hspace{1cm} (3.29)

It is found as it is expressed above.

In order for this expression to be written in a clear form, it is necessary to state the expansions of the \( r_{x1y4} \), \( r_{x2y4} \), \( r_{x3y4} \), and \( r_{x4y4} \). Since the \( r_{x1y4} \), \( r_{x2y4} \), \( r_{x3y4} \), and \( r_{x4y4} \) are the correlations between the exogenous variables, their values given in the Table 1 are used exactly. However, due to the fact that the \( Y_1 \) variable is an endogenous variable it is necessary for \( r_{y1y4} \) to be turned into the matrix form as it is in \( r_{y2x4} \).

When the \( r_{y1y4} \) is written in the matrix form and the necessary operations are performed \( r_{y2x4} \),

\[ r_{y1y4} = \left[ P_{y1x1} P_{y1x2} P_{y1x3} P_{y1x4} \right] \]

\[ r_{y1y4} = P_{y1x1} r_{x1y4} + P_{y1x2} r_{x2y4} + P_{y1x3} r_{x3y4} + P_{y1x4} r_{x4y4} \]  \hspace{1cm} (3.30)

\[ r_{y1y4} = P_{y1x1} r_{x1y4} + P_{y1x2} r_{x2y4} + P_{y1x3} r_{x3y4} + P_{y1x4} r_{x4y4} \]  \hspace{1cm} (3.31)

found as it is shown above.

When the correlation between the \( X_4 \) and \( Y_2 \) is separated into its components,

\[ r_{y2x4} = P_{y2x1} r_{x1y4} + P_{y2x2} r_{x2y4} + P_{y2x3} r_{x3y4} + P_{y2x4} r_{x4y4} + P_{y2y1} (P_{y1x1} r_{x1y4} + P_{y1x2} r_{x2y4} + P_{y1x3} r_{x3y4} + P_{y1x4} r_{x4y4}) \]  \hspace{1cm} (3.32)

\[ r_{y2x4} = P_{y2x1} r_{x1y4} + P_{y2x2} r_{x2y4} + P_{y2x3} r_{x3y4} + P_{y2x4} r_{x4y4} + P_{y2y1} P_{y1x1} r_{x1y4} + P_{y2y1} P_{y1x2} r_{x2y4} + P_{y2y1} P_{y1x3} r_{x3y4} + P_{y2y1} P_{y1x4} r_{x4y4} \]  \hspace{1cm} (3.33)

\[ r_{y2x4} = -0.058 \]  \hspace{1cm} (3.34)

found as it is expressed above.

All effects of the \( X_4 \) on \( Y_2 \) have been shown in the Table 8 in the analysis above.
Table 8: DE, IE, S and U Effects of the Father’s Education Level on the Achievement Test.

<table>
<thead>
<tr>
<th>pij</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{X_1Y_1}$ $r_{s_{X_1}}$</td>
<td>U</td>
<td>-0.021</td>
<td>37</td>
</tr>
<tr>
<td>$P_{X_2Y_2}$ $r_{s_{X_2}}$</td>
<td>U</td>
<td>-0.028</td>
<td>48</td>
</tr>
<tr>
<td>$P_{X_3Y_3}$ $r_{s_{X_3}}$</td>
<td>U</td>
<td>0.059</td>
<td>-103</td>
</tr>
<tr>
<td>$P_{X_4Y_4}$ $r_{s_{X_4}}$</td>
<td>DE</td>
<td>-0.091</td>
<td>157</td>
</tr>
<tr>
<td>$P_{Y_1Y_1}P_{X_1Y_1}$ $r_{s_{X_1}}$</td>
<td>U</td>
<td>0.032</td>
<td>-55</td>
</tr>
<tr>
<td>$P_{Y_1Y_1}P_{X_2Y_2}$ $r_{s_{X_2}}$</td>
<td>U</td>
<td>0.043</td>
<td>-74</td>
</tr>
<tr>
<td>$P_{Y_1Y_1}P_{X_3Y_3}$ $r_{s_{X_3}}$</td>
<td>U</td>
<td>-0.003</td>
<td>4</td>
</tr>
<tr>
<td>$P_{Y_1Y_1}P_{X_4Y_4}$ $r_{s_{X_4}}$</td>
<td>IE</td>
<td>-0.049</td>
<td>86</td>
</tr>
<tr>
<td>Total $r_{y_1y_4}$</td>
<td></td>
<td>-0.058</td>
<td>100</td>
</tr>
</tbody>
</table>

When the correlation between the $X_4$ and $Y_1$ is separated into its components as below,

$$ r_{y_1y_4} = P_{Y_1X_1} r_{s_{X_1}} + P_{Y_1X_2} r_{s_{X_2}} + P_{Y_1X_3} r_{s_{X_3}} + P_{Y_1X_4} r_{s_{X_4}} $$

(3.35)

$$ r_{y_1y_4} = 0.056 $$

(3.36)

$r_{y_1y_4}$ is found as it is shown above.

All effects of the $X_4$ on $Y_1$ in the above analysis have been shown in Table 9.

Table 9: DE, IE, S and U Effects of the Father’s Education Level on the Elementary School Diploma Grade

<table>
<thead>
<tr>
<th>pij</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{Y_1X_1}$ $r_{s_{X_1}}$</td>
<td>U</td>
<td>0.078</td>
<td>139</td>
</tr>
<tr>
<td>$P_{Y_1X_2}$ $r_{s_{X_2}}$</td>
<td>U</td>
<td>0.105</td>
<td>187</td>
</tr>
<tr>
<td>$P_{Y_1X_3}$ $r_{s_{X_3}}$</td>
<td>U</td>
<td>-0.006</td>
<td>-11</td>
</tr>
<tr>
<td>$P_{Y_1X_4}$ $r_{s_{X_4}}$</td>
<td>DE</td>
<td>-0.121</td>
<td>-215</td>
</tr>
<tr>
<td>Total $r_{y_1y_4}$</td>
<td></td>
<td>0.056</td>
<td>100</td>
</tr>
</tbody>
</table>

Correlation ($r_{y_1y_2}$) between the $Y_1$ and $Y_2$ is separated into its components as it is shown below.

When the ($r_{y_1y_2}$) is in the way as it is below,
\[ r_{y_2 y_1} = \begin{bmatrix} P_{y_2 x_1} & P_{y_2 x_2} & P_{y_2 x_3} & P_{y_2 x_4} & P_{y_2 y_1} \end{bmatrix} \begin{bmatrix} r_{y_1 y_1} \\ r_{x_2 y_1} \\ r_{x_3 y_1} \\ r_{x_4 y_1} \\ r_{y_3 y_1} \end{bmatrix} \]  

(3.37)

\[ r_{y_2 y_1} = P_{y_2 x_1} r_{x_1 y_1} + P_{y_2 x_2} r_{x_2 y_1} + P_{y_2 x_3} r_{x_3 y_1} + P_{y_2 x_4} r_{x_4 y_1} + P_{y_2 y_1} r_{y_3 y_1} \]  

(3.38)

(\( r_{y_2 y_1} \)) is found as it is stated above.

In order for this expression to be written in a clear form, it is necessary to state the expansions of \( r_{y_1 y_1}, r_{y_2 y_1}, r_{y_3 y_1}, r_{y_4 y_1} \), and \( r_{y_3 y_1} \). Since the \( r_{y_1 y_1}, r_{y_2 y_1}, r_{y_3 y_1}, \) and \( r_{y_4 y_1} \) have been found as [(3.4), (3.13), (3.22) and (3.31)] in the previous operations and written in matrix form. For this reason there was no need for repeating these matrices and directly written in places of their open forms below.

\[ r_{y_2 y_1} = P_{y_2 x_1} r_{x_1 y_1} + P_{y_2 x_2} r_{x_2 y_1} + P_{y_2 x_3} r_{x_3 y_1} + P_{y_2 x_4} r_{x_4 y_1} + P_{y_2 y_1} r_{y_3 y_1} \]

(3.39)

If these equations are written where they belong in the (3.38),

\[ r_{y_2 y_1} = P_{y_2 x_1} (P_{y_2 x_1} r_{x_1 y_1} + P_{y_2 x_2} r_{x_2 y_1} + P_{y_2 x_3} r_{x_3 y_1} + P_{y_2 x_4} r_{x_4 y_1} + P_{y_2 y_1} r_{y_3 y_1}) + \ldots \]

(3.40)

\[ r_{y_2 y_1} = 0.392634 \]  

(3.41)

\( r_{y_2 y_1} \) is found as it is stated above.

All effects of the \( Y_1 \) on \( Y_2 \) in the analysis above have been shown in Table 10.
Table 10: DE, IE, S and U Effects of the Elementary Diploma Grade on the Achievement Test

<table>
<thead>
<tr>
<th>$P_{ij}$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{X1Y1}$, $P_{X1Y2}$, $r_{X1Y1}$</td>
<td>S</td>
<td>0.00747</td>
<td>-1,903</td>
</tr>
<tr>
<td>$P_{X1Y1}$, $P_{X1Y2}$, $r_{X1Y2}$</td>
<td>U</td>
<td>-0.00521</td>
<td>-1,326</td>
</tr>
<tr>
<td>$P_{X1Y1}$, $P_{X1Y3}$, $r_{X1Y1}$</td>
<td>U</td>
<td>0.000297</td>
<td>0,0756</td>
</tr>
<tr>
<td>$P_{X1Y1}$, $P_{X1Y5}$, $r_{X1Y1}$</td>
<td>U</td>
<td>0.002575</td>
<td>0,656</td>
</tr>
<tr>
<td>$P_{X1Y2}$, $P_{X1Y1}$, $r_{X1Y2}$</td>
<td>U</td>
<td>-0.0051</td>
<td>-1,299</td>
</tr>
<tr>
<td>$P_{X1Y2}$, $P_{X1Y3}$, $r_{X1Y2}$</td>
<td>S</td>
<td>-0.01741</td>
<td>-4,434</td>
</tr>
<tr>
<td>$P_{X1Y2}$, $P_{X1Y4}$, $r_{X1Y5}$</td>
<td>U</td>
<td>0.000707</td>
<td>0,18</td>
</tr>
<tr>
<td>$P_{X1Y2}$, $P_{X1Y4}$, $r_{X1Y2}$</td>
<td>U</td>
<td>0.003822</td>
<td>0,8613</td>
</tr>
<tr>
<td>$P_{X1Y3}$, $P_{X1Y1}$, $r_{X1Y3}$</td>
<td>U</td>
<td>0.00927</td>
<td>2,5283</td>
</tr>
<tr>
<td>$P_{X1Y3}$, $P_{X1Y4}$, $r_{X1Y3}$</td>
<td>U</td>
<td>0.024111</td>
<td>6,1409</td>
</tr>
<tr>
<td>$P_{X1Y3}$, $P_{X1Y5}$, $r_{X1Y3}$</td>
<td>S</td>
<td>-0.00987</td>
<td>-2,513</td>
</tr>
<tr>
<td>$P_{X1Y3}$, $P_{X1Y5}$, $r_{X1Y3}$</td>
<td>U</td>
<td>-0.0072</td>
<td>-1,834</td>
</tr>
<tr>
<td>$P_{X1Y4}$, $P_{X1Y1}$, $r_{X1Y4}$</td>
<td>U</td>
<td>-0.00715</td>
<td>-1,82</td>
</tr>
<tr>
<td>$P_{X1Y4}$, $P_{X1Y2}$, $r_{X1Y4}$</td>
<td>U</td>
<td>-0.00957</td>
<td>-2,439</td>
</tr>
<tr>
<td>$P_{X1Y4}$, $P_{X1Y3}$, $r_{X1Y4}$</td>
<td>U</td>
<td>0.000598</td>
<td>0,1522</td>
</tr>
<tr>
<td>$P_{X1Y4}$, $P_{X1Y5}$, $r_{X1Y4}$</td>
<td>S</td>
<td>0.011011</td>
<td>2,8044</td>
</tr>
<tr>
<td>$P_{X1Y4}$, $r_{Y2Y1}$</td>
<td>DE</td>
<td>0.409</td>
<td>104,1682</td>
</tr>
<tr>
<td>Total</td>
<td>$r_{Y2Y1}$</td>
<td>0.393</td>
<td>100</td>
</tr>
</tbody>
</table>

When the values of (3.7), (3.9), (3.16), (3.18), (3.25), (3.27), (3.34), (3.36) and (3.41) found as the analyses’ result are compared to the Table 1, it is going to be seen that the result is same with the correlation values given in the table. Since the purpose of the path analysis is to separate the correlation between the variables into components; it is necessary for all components’ total to be equal to the correlation between the variables. For the obtained correlations values to equal with the correlation values given in the tables specified above corresponds one – to – one with the path model we established.

**Analyses Concerning with the demographic characteristics’ effects to the Achievement in the Computer Aided 7E Approach**

**Separation of the Correlations between the Demographic Variables Affecting the Physics Achievement into Components in the Path Model Established for the CA7E Approach**

When the correlations between the variables are separated into components and if the correlation between the $X_i$ and $Y_j$ is written by separating the components as it is seen below,
\begin{align}
r_{y_2x_1} &= [P_{y_2x_1} P_{y_2x_2} P_{y_2x_3} P_{y_2x_4} P_{y_2y_1}] \\
&= \begin{bmatrix}
r_{x_1y_1} \\
r_{x_2y_1} \\
r_{x_3y_1} \\
r_{x_4y_1} \\
r_{y_1y_1}
\end{bmatrix}
\tag{3.42}
\end{align}

\begin{align}
r_{y_2y_1} &= P_{y_2x_1} r_{x_1y_1} + P_{y_2x_2} r_{x_2y_1} + P_{y_2x_3} r_{x_3y_1} + P_{y_2x_4} r_{x_4y_1} + P_{y_2y_1} r_{y_1y_1} \\
&= \begin{bmatrix}
r_{x_1y_1} \\
r_{x_2y_1} \\
r_{x_3y_1} \\
r_{x_4y_1} \\
r_{y_1y_1}
\end{bmatrix}
\tag{3.43}
\end{align}

\( r_{y_2x_1} \) is found as it is explained above.

It is necessary to state the expansions of the \( r_{x_1y_1}, r_{x_2y_1}, r_{x_3y_1}, r_{x_4y_1}, \) and \( r_{y_1y_1}. \) Since the \( r_{x_1y_1}, r_{x_2y_1}, r_{x_3y_1}, \) and \( r_{x_4y_1} \) are the correlations between the exogenous variables, their values given in the Table 1 is used exactly.

However, due to the fact that the \( Y_1 \) variable is an endogenous variable it is necessary for \( r_{y_1y_1} \) to be turned into the matrix form as it is in \( r_{y_2x_1}. \) When the \( r_{y_1y_1} \) is written in the matrix form and the necessary operations are performed \( r_{y_1y_1}, \)

\begin{align}
r_{y_1y_1} &= [P_{y_1x_1} P_{y_1x_2} P_{y_1x_3} P_{y_1x_4}] \\
&= \begin{bmatrix}
r_{x_1y_1} \\
r_{x_2y_1} \\
r_{x_3y_1} \\
r_{x_4y_1} \\
r_{y_1y_1}
\end{bmatrix}
\tag{3.44}
\end{align}

\begin{align}
r_{y_1y_1} &= P_{y_1x_1} r_{x_1y_1} + P_{y_1x_2} r_{x_2y_1} + P_{y_1x_3} r_{x_3y_1} + P_{y_1x_4} r_{x_4y_1} + P_{y_1y_1} (P_{y_1x_1} r_{x_1y_1} + P_{y_1x_2} r_{x_2y_1} + P_{y_1x_3} r_{x_3y_1} + P_{y_1x_4} r_{x_4y_1}) \\
&= \begin{bmatrix}
r_{x_1y_1} \\
r_{x_2y_1} \\
r_{x_3y_1} \\
r_{x_4y_1} \\
r_{y_1y_1}
\end{bmatrix}
\tag{3.45}
\end{align}

\( r_{y_1y_1} \) is found as it is explained above.

When the correlation between \( X_1 \) and \( Y_2 \) is separated into its components,

\begin{align}
r_{y_2x_1} &= P_{y_2x_1} r_{x_1y_1} + P_{y_2x_2} r_{x_2y_1} + P_{y_2x_3} r_{x_3y_1} + P_{y_2x_4} r_{x_4y_1} + P_{y_2y_1} (P_{y_2x_1} r_{x_1y_1} + P_{y_2x_2} r_{x_2y_1} + P_{y_2x_3} r_{x_3y_1} + P_{y_2x_4} r_{x_4y_1}) \\
&= \begin{bmatrix}
r_{x_1y_1} \\
r_{x_2y_1} \\
r_{x_3y_1} \\
r_{x_4y_1} \\
r_{y_1y_1}
\end{bmatrix}
\tag{3.46}
\end{align}

\begin{align}
r_{y_2y_1} &= P_{y_2x_1} r_{x_1y_1} + P_{y_2x_2} r_{x_2y_1} + P_{y_2x_3} r_{x_3y_1} + P_{y_2x_4} r_{x_4y_1} + P_{y_2y_1} (P_{y_2x_1} r_{x_1y_1} + P_{y_2x_2} r_{x_2y_1} + P_{y_2x_3} r_{x_3y_1} + P_{y_2x_4} r_{x_4y_1}) \\
&= \begin{bmatrix}
r_{x_1y_1} \\
r_{x_2y_1} \\
r_{x_3y_1} \\
r_{x_4y_1} \\
r_{y_1y_1}
\end{bmatrix}
\tag{3.47}
\end{align}

\( r_{y_2y_1} = 0.040 \)
\tag{3.48}

\( r_{y_2x_1} \) is found as it is explained above.

All effects of the \( X_1 \) on \( Y_2 \) in the above analysis have been shown in Table 11.
Table 11: DE, IE, S and U Effects of the Mother’s Education Level on the Achievement Test

<table>
<thead>
<tr>
<th>P</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{X_1Y_1}r_{Y_1}$</td>
<td>DE</td>
<td>-0.087</td>
<td>-215</td>
</tr>
<tr>
<td>$P_{X_2Y_1}r_{X_2Y_1}$</td>
<td>U</td>
<td>0.0202</td>
<td>50</td>
</tr>
<tr>
<td>$P_{X_3Y_1}r_{X_3Y_1}$</td>
<td>U</td>
<td>0.0048</td>
<td>11.8</td>
</tr>
<tr>
<td>$P_{X_4Y_1}r_{X_4Y_1}$</td>
<td>U</td>
<td>0.0874</td>
<td>216</td>
</tr>
<tr>
<td>$P_{X_1X_2}P_{Y_1X_1}r_{X_1Y_1}$</td>
<td>IE</td>
<td>0.0047</td>
<td>11.7</td>
</tr>
<tr>
<td>$P_{X_1X_2}P_{Y_1X_2}r_{X_2Y_1}$</td>
<td>U</td>
<td>0.0069</td>
<td>17</td>
</tr>
<tr>
<td>$P_{X_1X_2}P_{Y_1X_3}r_{X_3Y_1}$</td>
<td>U</td>
<td>-0.0002</td>
<td>-0.5</td>
</tr>
<tr>
<td>$P_{X_1X_2}P_{Y_1X_4}r_{X_4Y_1}$</td>
<td>U</td>
<td>0.0036</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>0.040</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

When the correlation ($r_{Y_1X_1}$) between the $X_1$ and $Y_1$ is separated into its components as it is shown below,

$$r_{Y_1X_1} = P_{Y_1X_1}r_{Y_1X_1} + P_{Y_1X_2}r_{Y_1X_2} + P_{Y_1X_3}r_{Y_1X_3} + P_{Y_1X_4}r_{Y_1X_4}$$

(3.49)

$$r_{Y_1X_1} = 0.242$$

(3.50)

$r_{Y_1X_1}$ is found as it is stated above.

All effects of the $X_1$ on $Y_1$ in the analysis above have been shown in the Table 12.

Table 12. DE, IE, S and U Effects of the Mother’s Education Level on the Elementary School Diploma Grade

<table>
<thead>
<tr>
<th>P</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{Y_1X_1}r_{Y_1X_1}$</td>
<td>DE</td>
<td>0.076</td>
<td>31</td>
</tr>
<tr>
<td>$P_{Y_2X_1}r_{Y_2X_1}$</td>
<td>U</td>
<td>0.11</td>
<td>46</td>
</tr>
<tr>
<td>$P_{Y_3X_1}r_{Y_3X_1}$</td>
<td>U</td>
<td>0.003</td>
<td>-1</td>
</tr>
<tr>
<td>$P_{Y_4X_1}r_{Y_4X_1}$</td>
<td>U</td>
<td>0.059</td>
<td>24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>0.242</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Correlation ($r_{Y_2X_2}$) between the $X_2$ and $Y_2$ is separated into its components as shown below.

When $r_{Y_2X_2}$ is written as below,
\[ r_{y_2x_2} = \begin{bmatrix} r_{y_1x_1} \\ r_{y_2x_2} \\ r_{y_3x_3} \\ r_{y_4x_4} \end{bmatrix} \]

\[ r_{y_2x_2} = P_{y_2x_1}r_{y_1x_1} + P_{y_2x_2}r_{y_2x_2} + P_{y_2x_3}r_{y_3x_3} + P_{y_2x_4}r_{y_4x_4} + P_{y_2y_1}r_{y_1y_1} + P_{y_2y_3}r_{y_3y_3} + P_{y_2y_4}r_{y_4y_4} \]  

(3.52)

\[ r_{y_2x_2} \] is found as it is shown above.

In order for this expression to be written in a clear form, it is necessary to state the expansions of \( P_{y_2x_2} \), \( P_{y_3x_3} \), \( P_{y_4x_4} \), and \( P_{y_2y_2} \). Since the \( P_{y_2x_2} \), \( P_{y_3x_3} \), \( P_{y_4x_4} \), and \( P_{y_2y_2} \) are the correlations between the exogenous variables the values given in the Table 1 for them are used exactly. However, due to the fact that the \( Y_1 \) variable is an endogenous variable it is necessary for \( P_{y_2x_2} \) to be turned into the matrix form as it is in \( r_{y_2x_2} \). When the \( r_{y_2x_2} \) is written in the matrix form and the necessary operations are performed \( r_{y_2x_2} \),

\[ r_{y_2x_2} = \begin{bmatrix} r_{y_1x_1} \\ r_{y_2x_2} \\ r_{y_3x_3} \\ r_{y_4x_4} \end{bmatrix} \]

\[ r_{y_2x_2} = P_{y_1x_1}r_{y_1x_1} + P_{y_1x_2}r_{y_2x_2} + P_{y_1x_3}r_{y_3x_3} + P_{y_1x_4}r_{y_4x_4} \]

(3.53)

\[ r_{y_2x_2} = 0.111 \]  

(3.57)

All effects of the \( X_2 \) on \( Y_2 \) in the above analysis have been shown in the Table 13.
Table 13: DE, IE, S and U Effects of the Family’s Income Level on the Achievement Test

<table>
<thead>
<tr>
<th>$P_i$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{y_1x_1} r_{y_1x_1}$</td>
<td>U</td>
<td>-0,045</td>
<td>-39,5</td>
</tr>
<tr>
<td>$P_{y_2x_2} r_{y_2x_2}$</td>
<td>DE</td>
<td>0,039</td>
<td>34,2</td>
</tr>
<tr>
<td>$P_{y_3x_3} r_{y_3x_3}$</td>
<td>U</td>
<td>0,010</td>
<td>10,5</td>
</tr>
<tr>
<td>$P_{y_4x_4} r_{y_4x_4}$</td>
<td>U</td>
<td>0,089</td>
<td>78,1</td>
</tr>
<tr>
<td>$P_{y_1x_1} r_{y_1x_1}$</td>
<td>U</td>
<td>0,002</td>
<td>2,1</td>
</tr>
<tr>
<td>$P_{y_2x_2} r_{y_2x_2}$</td>
<td>IE</td>
<td>0,013</td>
<td>11,6</td>
</tr>
<tr>
<td>$P_{y_3x_3} r_{y_3x_3}$</td>
<td>U</td>
<td>-0,0004</td>
<td>-0,3</td>
</tr>
<tr>
<td>$P_{y_4x_4} r_{y_4x_4}$</td>
<td>U</td>
<td>0,0037</td>
<td>3,3</td>
</tr>
<tr>
<td>Total</td>
<td>$r_{y_1}^{X_1}$</td>
<td>0,111</td>
<td>100</td>
</tr>
</tbody>
</table>

When the correlation ($r_{y_1}^{X_1}$) between $X_1$ and $Y_1$ is separated into its components as shown below,

$$r_{y_1}^{X_1} = P_{y_1x_1} r_{y_1x_1} + P_{y_2x_2} r_{y_2x_2} + P_{y_3x_3} r_{y_3x_3} + P_{y_4x_4} r_{y_4x_4}$$

(3.58)

$$r_{y_1}^{X_1} = 0,306$$

(3.59)

$r_{y_1}^{X_1}$ is found as it is shown above.

All effects of the $X_1$ on $Y_1$ in the above analysis have been shown in Table 14.

Table 14: DE, IE, S and U Effects of the Family’s Income Level on the Elementary School Diploma Grade

<table>
<thead>
<tr>
<th>$P_i$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{y_1x_1} r_{y_1x_1}$</td>
<td>U</td>
<td>0,039</td>
<td>13</td>
</tr>
<tr>
<td>$P_{y_2x_2} r_{y_2x_2}$</td>
<td>DE</td>
<td>0,214</td>
<td>70</td>
</tr>
<tr>
<td>$P_{y_3x_3} r_{y_3x_3}$</td>
<td>U</td>
<td>-0,007</td>
<td>-2</td>
</tr>
<tr>
<td>$P_{y_4x_4} r_{y_4x_4}$</td>
<td>U</td>
<td>0,060</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>$r_{y_1}^{X_1}$</td>
<td>0,306</td>
<td>100</td>
</tr>
</tbody>
</table>

Correlation $r_{y_1}^{X_1}$ between the $X_1$ and $Y_1$ is separated into its components as below.

When the $r_{y_1}^{X_1}$ is written as below,
\[
\begin{bmatrix}
  r_{x_3x_5} \\
  r_{x_2x_5} \\
  r_{x_1x_5} \\
  r_{x_4x_5} \\
  r_{x_5} \\
\end{bmatrix}
\]

(3.60)

\[
\begin{align*}
  r_{y_3x_5} &= P_{y_2x_1}r_{x_1} + P_{y_2x_2}r_{x_2} + P_{y_2x_3}r_{x_3} + P_{y_2x_4}r_{x_4} + P_{y_2x_5}r_{x_5} \\
  r_{y_2x_5} &= P_{y_1x_1}r_{x_1} + P_{y_1x_2}r_{x_2} + P_{y_1x_3}r_{x_3} + P_{y_1x_4}r_{x_4} + P_{y_1x_5}r_{x_5} \\
\end{align*}
\]

(3.61)

In order for this expression to be written in a clear form, it is necessary to state the expansions of \( r_{x_1x_5} \), \( r_{x_2x_5} \), \( r_{x_3x_5} \), \( r_{x_4x_5} \), and \( r_{x_5} \). Since the \( r_{x_1x_5} \), \( r_{x_2x_5} \), \( r_{x_3x_5} \), and \( r_{x_4x_5} \) are the correlations between the exogenous variables, the values given in the Table 1 for them are used exactly. However, due to the fact that the \( y_1 \) variable is an endogenous variable it is necessary for \( r_{y_1x_5} \) to be turned into the matrix form as it is in \( r_{y_2x_5} \).

When the \( r_{y_1x_5} \) is written in the matrix form and the necessary operations are performed, we get

\[
\begin{bmatrix}
  r_{y_1x_5} \\
  r_{y_2x_5} \\
  r_{y_3x_5} \\
  r_{y_4x_5} \\
  r_{y_5} \\
\end{bmatrix}
\]

(3.62)

\[
\begin{align*}
  r_{y_3x_5} &= P_{y_1x_1}r_{x_1} + P_{y_1x_2}r_{x_2} + P_{y_1x_3}r_{x_3} + P_{y_1x_4}r_{x_4} + P_{y_1x_5}r_{x_5} \\
  r_{y_2x_5} &= P_{y_1x_1}r_{x_1} + P_{y_1x_2}r_{x_2} + P_{y_1x_3}r_{x_3} + P_{y_1x_4}r_{x_4} + P_{y_1x_5}r_{x_5} \\
  r_{y_1x_5} &= P_{y_1x_1}r_{x_1} + P_{y_1x_2}r_{x_2} + P_{y_1x_3}r_{x_3} + P_{y_1x_4}r_{x_4} + P_{y_1x_5}r_{x_5} \\
\end{align*}
\]

(3.63)

found as shown above.

When the correlation between \( x_3 \) and \( y_2 \) is separated into its components,

\[
\begin{align*}
  r_{y_3x_5} &= P_{y_2x_1}r_{x_1} + P_{y_2x_2}r_{x_2} + P_{y_2x_3}r_{x_3} + P_{y_2x_4}r_{x_4} + P_{y_2x_5}r_{x_5} + P_{y_2x_1}r_{x_1} + P_{y_2x_2}r_{x_2} + P_{y_2x_3}r_{x_3} + P_{y_2x_4}r_{x_4} + P_{y_2x_5}r_{x_5} \\
  r_{y_2x_5} &= P_{y_2x_1}r_{x_1} + P_{y_2x_2}r_{x_2} + P_{y_2x_3}r_{x_3} + P_{y_2x_4}r_{x_4} + P_{y_2x_5}r_{x_5} + P_{y_2x_1}r_{x_1} + P_{y_2x_2}r_{x_2} + P_{y_2x_3}r_{x_3} + P_{y_2x_4}r_{x_4} + P_{y_2x_5}r_{x_5} \\
  r_{y_1x_5} &= P_{y_1x_1}r_{x_1} + P_{y_1x_2}r_{x_2} + P_{y_1x_3}r_{x_3} + P_{y_1x_4}r_{x_4} + P_{y_1x_5}r_{x_5} + P_{y_1x_1}r_{x_1} + P_{y_1x_2}r_{x_2} + P_{y_1x_3}r_{x_3} + P_{y_1x_4}r_{x_4} + P_{y_1x_5}r_{x_5} \\
\end{align*}
\]

(3.64)

(3.65)

\[
\begin{align*}
  r_{y_3x_5} &= 0.081 \\
  r_{y_2x_5} &= 0.081 \
\end{align*}
\]

(3.66)

\( r_{y_3x_5} \) is found as above.

All effects of the \( x_3 \) on \( y_2 \) in the above analysis have been shown in Table 15.
Table 15: DE, IE, S and U Effects of the Gender on the Achievement Test

<table>
<thead>
<tr>
<th>$P_{ij}$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{Y_1X_1} r_{x_1y_1}$</td>
<td>U</td>
<td>-0.011</td>
<td>-13.4</td>
</tr>
<tr>
<td>$P_{Y_2X_2} r_{x_2y_2}$</td>
<td>U</td>
<td>0.010</td>
<td>12.5</td>
</tr>
<tr>
<td>$P_{Y_3X_3} r_{x_3y_3}$</td>
<td>DE</td>
<td>0.038</td>
<td>46.6</td>
</tr>
<tr>
<td>$P_{Y_4X_4} r_{x_4y_4}$</td>
<td>U</td>
<td>0.040</td>
<td>49.4</td>
</tr>
<tr>
<td>$P_{Y_1Y_1} P_{Y_2X_2} r_{x_2y_2y_1}$</td>
<td>U</td>
<td>0.0006</td>
<td>0.7</td>
</tr>
<tr>
<td>$P_{Y_1Y_1} P_{Y_3X_3} r_{x_3y_3y_1}$</td>
<td>U</td>
<td>0.0035</td>
<td>4.2</td>
</tr>
<tr>
<td>$P_{Y_1Y_1} P_{Y_4X_4} r_{x_4y_4y_1}$</td>
<td>IE</td>
<td>-0.0016</td>
<td>-2</td>
</tr>
<tr>
<td>$P_{Y_1Y_1} P_{Y_4X_4} r_{x_4y_4y_1}$</td>
<td>U</td>
<td>0.0017</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$r_{y_3y_1}$</td>
<td>0.081</td>
<td>100</td>
</tr>
</tbody>
</table>

When the correlation ($r_{y_3y_1}$) between the $X_3$ and $Y_1$ is separated into its components as below,

$$r_{y_3y_1} = P_{Y_1X_1} r_{x_1y_1} + P_{Y_2X_2} r_{x_2y_2} + P_{Y_3X_3} r_{x_3y_3} + P_{Y_4X_4} r_{x_4y_4}$$

$$r_{y_3y_1} = 0.066$$

$r_{y_3y_1}$ is found as above.

All effects of the $X_3$ on $Y_1$ in the above analysis have been shown in Table 16.

Table 16: DE, IE, S and U Effects of the Gender on the Elementary School Diploma Grade

<table>
<thead>
<tr>
<th>$P_{ij}$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{Y_1X_1} r_{x_1y_1}$</td>
<td>U</td>
<td>0.010</td>
<td>14</td>
</tr>
<tr>
<td>$P_{Y_2X_2} r_{x_2y_2}$</td>
<td>U</td>
<td>0.055</td>
<td>84</td>
</tr>
<tr>
<td>$P_{Y_3X_3} r_{x_3y_3}$</td>
<td>DE</td>
<td>-0.026</td>
<td>-39</td>
</tr>
<tr>
<td>$P_{Y_4X_4} r_{x_4y_4}$</td>
<td>U</td>
<td>0.027</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$r_{y_3y_1}$</td>
<td>0.066</td>
<td>100</td>
</tr>
</tbody>
</table>

Correlation ($r_{y_2y_4}$) between the $X_2$ and $Y_2$ is separated into its components as below.

When $r_{y_2y_4}$ is written as below,
In order for this expression to be written in a clear form, it is necessary to state the expansions of the $r_{y_4 x_4}$, $r_{y_4 x_2}$, $r_{y_4 x_3}$, and $r_{y_4 x_4}$. Since the $r_{y_4 x_4}$, $r_{y_4 x_2}$, $r_{y_4 x_3}$, and $r_{y_4 x_4}$ are the correlations between the exogenous variables, their values given in the Table 1 is used exactly. However, due to the fact that the $Y_1$ variable is an endogenous variable it is necessary for $r_{y_1 x_4}$ to be turned into the matrix form as it is in $r_{y_2 x_4}$.

When the $r_{y_1 x_4}$ is written in the matrix form and the necessary operations are performed $r_{y_2 x_4}$,

$$r_{y_2 x_4} = P_{y_2 x_4} P_{x_2 y_4} + P_{y_2 x_2} P_{x_2 y_4} + P_{y_2 x_3} P_{x_3 y_4} + P_{y_2 x_4} P_{x_4 y_4}$$

(3.70)

$r_{y_2 x_4}$ is found as above.

In order for this expression to be written in a clear form, it is necessary to state the expansions of the $r_{y_2 x_4}$, $r_{y_4 x_2}$, $r_{y_4 x_3}$, and $r_{y_4 x_4}$. Since the $r_{x_4 y_2}$, $r_{x_4 y_3}$, and $r_{x_4 y_4}$ are the correlations between the exogenous variables, their values given in the Table 1 is used exactly. However, due to the fact that the $Y_1$ variable is an endogenous variable it is necessary for $r_{x_1 y_4}$ to be turned into the matrix form as it is in $r_{x_2 y_4}$.

When the $r_{x_1 y_4}$ is written in the matrix form and the necessary operations are performed $r_{x_2 y_4}$,

$$r_{x_2 y_4} = P_{x_2 y_4} P_{x_2 y_2} P_{y_2 x_4} + P_{x_2 y_2} P_{x_2 y_3} P_{y_3 x_4} + P_{x_2 y_2} P_{x_2 y_4} P_{y_4 x_4}$$

(3.71)

$r_{x_2 y_4}$ is found as above.

All effects of the $X_4$ on $Y_2$ in the analyses above have been shown in Table 17.
Table 17: DE, IE, S and U Effects of the Father’s Education Level on the Achievement Test

<table>
<thead>
<tr>
<th>$P_{ij}$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{Y1X4} r_{y4x4}$</td>
<td>U</td>
<td>-0.055</td>
<td>-41.2</td>
</tr>
<tr>
<td>$P_{Y2X4} r_{y2x4}$</td>
<td>U</td>
<td>0.025</td>
<td>18.8</td>
</tr>
<tr>
<td>$P_{Y3X4} r_{y3x4}$</td>
<td>U</td>
<td>0.011</td>
<td>8.3</td>
</tr>
<tr>
<td>$P_{Y4X4} r_{y4x4}$</td>
<td>DE</td>
<td>0.137</td>
<td>101.6</td>
</tr>
<tr>
<td>$P_{Y1Y1} P_{Y1X4} r_{y1y4}$</td>
<td>U</td>
<td>0.003</td>
<td>2.2</td>
</tr>
<tr>
<td>$P_{Y2Y1} P_{Y2X4} r_{y2y4}$</td>
<td>U</td>
<td>0.008</td>
<td>6.4</td>
</tr>
<tr>
<td>$P_{Y3Y1} P_{Y3X4} r_{y3y4}$</td>
<td>U</td>
<td>-0.0005</td>
<td>-0.3</td>
</tr>
<tr>
<td>$P_{Y4Y1} P_{Y4X4} r_{y4y4}$</td>
<td>IE</td>
<td>0.005</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Total $r_{y2y4}$ 0.134 100

When the correlation ($r_{y1x4}$) between the $X_4$ and $Y_1$ is separated into its components as below,

$$r_{y1x4} = P_{Y1X4} r_{y1x4} + P_{Y2X4} r_{y2x4} + P_{Y3X4} r_{y3x4} + P_{Y4X4} r_{y4x4}$$

(3.76)

$$r_{y1x4} = 0.271$$

(3.77)

$r_{y1x4}$ is found as shown above.

All effects of the $X_4$ on $Y_1$ in the above analysis have been shown in Table 18.

Table 18. DE, IE, S and U Effects of the Father’s Education Level on the Elementary School Diploma Grade

<table>
<thead>
<tr>
<th>$P_{ij}$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{Y1X4} r_{y1x4}$</td>
<td>U</td>
<td>0.048</td>
<td>17</td>
</tr>
<tr>
<td>$P_{Y2X4} r_{y2x4}$</td>
<td>U</td>
<td>0.139</td>
<td>51</td>
</tr>
<tr>
<td>$P_{Y3X4} r_{y3x4}$</td>
<td>U</td>
<td>-0.008</td>
<td>-2</td>
</tr>
<tr>
<td>$P_{Y4X4} r_{y4x4}$</td>
<td>DE</td>
<td>0.092</td>
<td>34</td>
</tr>
</tbody>
</table>

Total $r_{y2y4}$ 0.271 100

Correlation ($r_{y2y4}$) between the $Y_1$ and $Y_2$ is separated into its components as below.

When $r_{y2y4}$ is written as below,
\[ r_{y_2y_1} = \begin{bmatrix} r_{y_1y_1} \\ r_{y_2y_1} \\ r_{y_3y_1} \\ r_{y_4y_1} \\ r_{y_1y_1} \end{bmatrix} \]

(3.78)

\[ r_{y_2y_1} = P_{y_2x_1} r_{x_1y_1} + P_{y_2x_2} r_{x_2y_1} + P_{y_2x_3} r_{x_3y_1} + P_{y_2x_4} r_{x_4y_1} + P_{y_2y_1} r_{y_1y_1} \]  

(3.79)

\( r_{y_2y_1} \) is found as above.

In order for this expression to be written in a clear form, it is necessary to state the expansions of \( rx_{1}y_{1}, rx_{2}y_{1}, rx_{3}y_{1}, rx_{4}y_{1}, \) and \( ry_{1}y_{1} \). Since the \( rx_{1}y_{1}, rx_{2}y_{1}, rx_{3}y_{1},rx_{4}y_{1}, \) and \( ry_{1}y_{1} \) have been found as \[(3.45), (3.54), (3.63)\] and \( (3.72) \) in the previous operations and written in matrix form. For this reason there was no need for repeating these matrices and directly written in places of their open forms below.

\[ r_{y_1y_1} = P_{y_1x_1} r_{x_1y_1} + P_{y_1x_2} r_{x_2y_1} + P_{y_1x_3} r_{x_3y_1} + P_{y_1x_4} r_{x_4y_1} \]
\[ r_{y_2y_2} = P_{y_2x_1} r_{x_1y_2} + P_{y_2x_2} r_{x_2y_2} + P_{y_2x_3} r_{x_3y_2} + P_{y_2x_4} r_{x_4y_2} \]
\[ r_{y_3y_3} = P_{y_3x_1} r_{x_1y_3} + P_{y_3x_2} r_{x_2y_3} + P_{y_3x_3} r_{x_3y_3} + P_{y_3x_4} r_{x_4y_3} \]
\[ r_{y_4y_4} = P_{y_4x_1} r_{x_1y_4} + P_{y_4x_2} r_{x_2y_4} + P_{y_4x_3} r_{x_3y_4} + P_{y_4x_4} r_{x_4y_4} \]

When these values are written in their places in equation 3.79, \( r_{y_2y_1} \),

\[ r_{y_2y_1} = P_{y_2x_1} (P_{y_1x_1} r_{x_1y_1} + P_{y_1x_2} r_{x_2y_1} + P_{y_1x_3} r_{x_3y_1} + P_{y_1x_4} r_{x_4y_1}) + P_{y_2x_2} (P_{y_1x_1} r_{x_1y_2} + P_{y_1x_2} r_{x_2y_2} + P_{y_1x_3} r_{x_3y_2} + P_{y_1x_4} r_{x_4y_2}) \]
\[ + P_{y_2x_3} (P_{y_1x_1} r_{x_1y_3} + P_{y_1x_2} r_{x_2y_3} + P_{y_1x_3} r_{x_3y_3} + P_{y_1x_4} r_{x_4y_3}) + P_{y_2x_4} (P_{y_1x_1} r_{x_1y_4} + P_{y_1x_2} r_{x_2y_4} + P_{y_1x_3} r_{x_3y_4} + P_{y_1x_4} r_{x_4y_4}) \]
\[ + P_{y_2y_1} r_{y_1y_1} \]

(3.80)

\[ r_{y_2y_1} = P_{y_2x_1} (P_{y_1x_1} r_{x_1y_1} + P_{y_1x_2} r_{x_2y_1} + P_{y_1x_3} r_{x_3y_1} + P_{y_1x_4} r_{x_4y_1}) + P_{y_2x_2} (P_{y_1x_1} r_{x_1y_2} + P_{y_1x_2} r_{x_2y_2} + P_{y_1x_3} r_{x_3y_2} + P_{y_1x_4} r_{x_4y_2}) \]
\[ + P_{y_2x_3} (P_{y_1x_1} r_{x_1y_3} + P_{y_1x_2} r_{x_2y_3} + P_{y_1x_3} r_{x_3y_3} + P_{y_1x_4} r_{x_4y_3}) + P_{y_2x_4} (P_{y_1x_1} r_{x_1y_4} + P_{y_1x_2} r_{x_2y_4} + P_{y_1x_3} r_{x_3y_4} + P_{y_1x_4} r_{x_4y_4}) \]
\[ + P_{y_2y_1} r_{y_1y_1} \]

(3.81)

\[ r_{y_2y_1} = 0.093 \]  

(3.82)

is found as above.

All effects of the \( Y_1 \) on \( Y_2 \) in the above analysis are shown in Table 19.
Table 19: DE, IE, S and U Effects of the Elementary School Diploma Grade on the Achievement Test

<table>
<thead>
<tr>
<th>$p_i$</th>
<th>Form of Effect</th>
<th>Magnitude</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_1X_2}$</td>
<td>S</td>
<td>-0.0066</td>
<td>-7.14</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_1X_3}$</td>
<td>U</td>
<td>-0.0096</td>
<td>-10.41</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_1X_4}$</td>
<td>U</td>
<td>0.0003</td>
<td>0.31</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_1X_5}$</td>
<td>U</td>
<td>-0.0051</td>
<td>-5.51</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_2X_3}$</td>
<td>U</td>
<td>0.0015</td>
<td>1.66</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_2X_4}$</td>
<td>S</td>
<td>0.0083</td>
<td>9.01</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_2X_5}$</td>
<td>U</td>
<td>-0.0003</td>
<td>-0.29</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_3X_4}$</td>
<td>U</td>
<td>0.0023</td>
<td>2.52</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_3X_5}$</td>
<td>U</td>
<td>0.0004</td>
<td>0.39</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_4X_5}$</td>
<td>U</td>
<td>0.0021</td>
<td>2.29</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_5X_3}$</td>
<td>S</td>
<td>-0.0010</td>
<td>-1.07</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_5X_4}$</td>
<td>U</td>
<td>0.0010</td>
<td>1.11</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_5X_5}$</td>
<td>U</td>
<td>0.0066</td>
<td>7.17</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_5X_4}$</td>
<td>U</td>
<td>0.019</td>
<td>20.57</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_5X_5}$</td>
<td>U</td>
<td>-0.0010</td>
<td>-1.13</td>
</tr>
<tr>
<td>$P_{YX_1}$ $P_{YX_2}$ $r_{X_5X_6}$</td>
<td>S</td>
<td>0.0126</td>
<td>13.60</td>
</tr>
<tr>
<td>$P_{YX_1}$ $r_{X_1X_1}$</td>
<td>DE</td>
<td>0.062</td>
<td>66.91</td>
</tr>
</tbody>
</table>

When the values (3.48), (3.50), (3.57), (3.59), (3.66), (3.68), (3.75), (3.77) and (3.82) found as the analyses’ result compared with Table 1; it is going to be seen that the result is the same with the correlation values given in the table.

**DISCUSSION**

The path analysis in its core is the method of separating the coefficient’s components between the variables. It is a method that shows the contribution margins of each of the variables to this correlation and a method that has relative results in some respects by considering all the variables, which are being analyzed collectively and not tackling the single correlation between the two variables on its own. The components’ effect margins forming the correlation as connected to the increase and decrease of variables changes’ number. In this study, only five variables have been handled and the unobservable affects that each of the variable’s observable and together with the other variables effect over the result variables have been analyzed. The other variables’ effects that remain outside of the variables considered in this study have been stated with a symbol of “e” and their effect value has been shown however, they have not been used in the path analysis’s calculations. When looking at the effects’ path coefficients shown with the symbol “e” (Figure 1); it is seen that these values are...
larger than the variables' path coefficients used in our study in certain stated forms. It has been realized from
the findings obtained that the variables remaining on the outside of the variables used in this study will also
have significant effects over the result variables. The contributions provided to the education area are going to
increase with studies using more variables.

While the data belonging to the students in each of two groups have been analyzing; the mother’s education
level’s effects, family’s income status, gender, father’s education level on the student’s achievement and on
the elementary school achievement and the student’s grade have been discussed in the first step and in the
second step on the other hand, these variables’ effects together with the elementary school diploma grade on
the student’s achievement has been discussed.

Since the effect’s table evaluation for each one of the cause variable on the result variable in the path analysis
is made with a similar logic, only the interpretations belonging to the first two tables (Table 2 and Table 3) have
been given in a clear form here.

**Separating the Mother’s Education Level’s Effects in the Student Groups Receiving Education with CACL on
the Student’s Achievement and Elementary School Diploma Grade into their Components**

When Table 1 is examined, the correlation between the obtained the student’s achievement score and the
mother’s education level is seen as 0.030. According to the value in the Table 1, there is a positive direction
between the mother’s education level and the achievement that the student achieved in this study. With a
clearer statement, it is seen as if an increase in the mother’s education level is affecting the student’s
achievement in this study in a positive direction. When this correlation is separated into its components (Table
2) on the other hand, the mother’s education level’s observable effect on the student’s achievement is -0.045
and the contribution of this size in the correlation on the other hand is a negative value of 149%. The
unobservable contribution (IE) that the mother’s education level adds to the student’s achievement over the
elementary school diploma grade has a size of 0.068 and contribution share of 225%. There are also U effects
that the mother’s level of education has over the student’s achievement. These are the effects made over the
family’s income level, gender and father’s level of education respectively. And their sizes and contribution
shares in the total respectively are in form of -0.031 (102% negative), 0.060 (198% negative) and -0.043 (143%
negative). There are also three different U effects originating from the relationship between the other
variables (family’s income level, gender and the father’s education level respectively) of the mother’s
education level made over the elementary school diploma grade. And their sizes and contribution shares in the
total respectively are in form of 0.047 (157%), -0.003 (9% negative) and -0.023 (77% negative). If looked
closely the observable effect of the mother’s education level on the student’s achievement is in the negative
direction and while it is nearly 1.5 times larger that the observed value, this negativity gets removed with the
total contributions of the unobservable effects (IE and U) and shown a positive effect to the achievement as a
result. Also, while the mother’s education level makes a negative impact to the measured achievement in our
study, it made a positive impact on the student’s elementary school achievement and the elementary school
achievement’s increase sourcing from this positive impact has provided the biggest contribution to the
student’s achievement (225%).

In the same way, the effects of the mother’s education level over the elementary school diploma grade of the
student are given in Table 3. The size of the observable correlation coefficient between the two variables in
Table 3 is seen as 0.217 (Table 16) and as a positive effect. When we separate the value of this correlation into
its components, the mother’s education level has one observable (DE) and three unobservable U effects which
are origination from the relationships with the family’s income level, gender and the father’s education level
respectively over the elementary school diploma grade of the student. While the size and contribution in total
of the observable effect is 0.166 (76%), the sizes and contributions in total of the U effects origination from the
relationship between the reason variables are in form of 0.115 (53%), -0.007 (3% negative) and -0.057 (26%
negative) respectively. The observable effect of the mother’s education on the elementary school diploma
grade forms only the three quarters of the total effect. An effect about the half the proportion of the total effect on the other hand rises from the U effect that the mother’s education level makes over the family’s income level. Even thought the total of the both effects is greater that the total effect (0.217) this effect with the negative U effects made over the gender and father’s education level this effect has decreased and an observable correlation has been formed.

**Relationships Found Significant from the Statistical Angle in the Path Analysis**

When we analyze the relationships between the cause and result variables according to this method suggested by Author (2008) and when we examine the correlation values in the Table 1 for analyzing the demographic variables’ effects (X\(_1\): Mother’s education level, X\(_2\): Family’s income level, X\(_3\): Gender and X\(_4\): Father’s education level) on Y\(_1\) (Elementary school diploma grade) and all their influences together with Y\(_1\) on the Y\(_2\) (the students’ physics achievement scores in the study); consistency coefficients obtained by following the method suggested above are found in form of,

\[
\begin{align*}
T (X_1; Y_2) &= 0 \\
T (X_2; Y_2) &= 0 \\
T (X_3; Y_2) &= 0.5 \\
T (X_4; Y_2) &= 0 \\
T (X_1; Y_1) &= 1 \\
T (X_2; Y_1) &= 1 \\
T (X_3; Y_1) &= 0 \\
T (X_4; Y_1) &= 0.5 \\
T (Y_1; Y_2) &= 0.5
\end{align*}
\]

It has been seen that in the bottom line of the method suggested by Author (2008), X\(_1\), X\(_2\), X\(_3\) and X\(_4\) have not had a significant influence on Y\(_2\) the result variable. Continuing on with this result, it can be said that the demographic characteristics tackled in this short study of four weeks have not had influence over the physics achievement that the student obtained in the study. Together with this, due to the fact that the consistency coefficients between the X\(_1\), X\(_2\) and X\(_4\) cause variables and the Y\(_1\) result variable have been not greater values than “0”; it is being thought that the demographic characteristics influence the achievements, which are going to be obtained from long term studies. Also the influence’s consistency coefficient of the X\(_3\) variable on Y\(_1\) being “0” has been interpreted as the cause variable X\(_3\) has no influence on the result variable Y\(_1\). Due to the fact that the demographic characteristics have not had a significant influence on the achievement in short term; it is being considered that the increase seen in the student’s achievement occurred in connection to the learning approach applied in the current study.

When the variables with consistency coefficient greater than “0” are examined and since the consistency coefficient between the X\(_3\) and Y\(_2\) are 0.5 the DE values of the both variables in total effect have been taken into consideration. The DE effect of a cause variable on another result variable is once again the correlation ratio between the same two variables of the path correlation between the same two variables given in Figure 1. While the total effect value given in Table 1 for CA7E is 0.081 (\(r_{x_3, y_1}\)), it has been seen that X\(_3\) has an effect value in size of 0.038 that forms only the 46.6% of this total effect. Together with this, if the contribution of X\(_3\) is 46.6% in the effect in size of 0.081, which is insignificant, is its observable effect; it is a value even lower than the observed correlation. In this case, it can be said that the gender variable do not have a defining role in comparing the achievements of the students, who are receiving education with CA7E. Completely opposite of this condition, a significant relationship between the X\(_3\) and Y\(_2\) has been observed in CACL (P<0.01). When it is considered that the DE contribution of the X\(_3\) in the total effect is 109%, it has been seen that this amount is larger and more significant that the observable correlation value. However, with the other unobservable negative effects over other variables, the effect of X\(_3\) on Y\(_2\) has declined. Despite this significanace, parallel to
the consistency value $T(X_3:Y_1) = 0$ defined for the gender variable and elementary school achievement, it has been determined that it is not going to be effective on the physics achievement of the student in our short term study and it has not been taken into consideration. It is also being stated in the study of Murray-Harvey (1993) that the gender is not effective on achievement. Murray-Harvey (1993) in their studies have examined the relationships between the studying approaches, learning styles and control areas of the 423 students, who are freshmen in the education and nursing department with the path analysis and researched the effects on their achievements. At the end of the study on the other hand, the have stated that the variance 44% in increasing academic achievement explains ($\beta = 0.45$) the students recognition of their cognitive abilities and gender, age and learning approaches don’t have a significant contribution to achievement. This study is in a supporting quality of our findings on account of indicating that the gender is not an effective factor over the achievement of student.

Due to the fact that the values of $T(X_4:Y_1)$ and $T(Y_1:Y_2)$ are “0.5”, the DE values in the total effect formed over the result variable that the each two variables have over the result variable is considered. The observable effect contributions of the $T(X_4:Y_1)$ in the total correlation respectively are an insignificant value of 125% (negative) and -0.0121 for CACL and a 24% ratio and 0.092 of an effect for the CA7E. The DE value which has a contribution of only 34% in value of 0.271 can be seen as if it is significant only in the group applied CA7E yet has a very small value that can be qualified as insignificant. Therefore, the interpretation that the $X_4$ variable, in other words the father’s education level, does not have a significant effect on the student’s elementary school achievement grade has been made.

The observable contributions of $T(Y_1:Y_2)$ in the total correlation respectively are a significant value of 0.409 and a ratio of 104% for CACL ($P<0.01$) and a non-significant value of 0.062 and a ratio of 66% for CA7E. Due to the fact that the contribution of $Y_1$ in size of 0.393, which seems to be significant in only the group applied CA7E, is found to be in level of 99% significance; it has been interpreted as the elementary school diploma grade has a positive effect on the student’s achievement. This result shows a parallelism with the study results of the (Zeeger, 2004; Archer and friends, 1999 and Lietz, 1996) informing that the initial knowledge and graduation scores of the students have a positive impact on the student’s achievement.

The consistency values of $T(X_1:Y_1) = 1$ and $T(X_2:Y_1) = 1$ show that there is a significant relationship between the $X_1$ and $X_2$ cause variables and $Y_1$ result variable and that the cause variables increased the result variable in a positive direction. In other words, the increase in the mother’s education level and the family’s income affect the students’ elementary school diploma grade of in a positive direction. It has also been stated this two variables increase the student’s achievement in long term in studies where the mother’s education level’s effects and the family’s income level have on the student’s achievement are analyzed (Bleeker and Jacobs, 2006; Davis-Kean, 2005; Halle and friends, 1997 and Alexander and friends, 1994). Among these researchers, Halle and friends (1997 and Davis – Kean (2005) also express that the father’s education level besides mother’s also has a positive impact on the student’s achievement.

CONCLUSION AND SUGGESTIONS

In the end of the analyses made with the path analysis; it has been seen that the mother’s education level and the family’s income level have a clear effect on the student’s elementary school diploma grades despite the fact that the demographic characteristics’ observable effects on the students’ physics achievements obtaining from this study have been not able to be determined [$T(X_1:Y_1) = 1$ and $T(X_2:Y_1) = 1$]. While the demographic characteristics’ effects on the achievement are being interpreted, the conclusion that the mentioned demographic characteristics have not been affected the achievement in short termed studies yet the mother’s education level, family’s income level and the students’ initial knowledge providing significant and positive contributions to the achievement in the long termed learning stages have been made. In this context, it is
being thought that keeping in consideration of the demographic characteristics while planning the instruction and learning processes in long term stages will make positive contributions to the student’s achievement.

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