

Detection of Students' Interest With the Logistics Model

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Abstract – The focus of this research is to analyze the model that classifies student personality type based on demographic factors. This model can identify students' career interests. It is important to know students' career interest in accordance with their personalities. For the analysis method, the researchers applied multinomial logistics regression analysis with consideration to the nominal data scale of Holland's Personality Types, namely realistic, investigative, artistic, social, enterprising, and conventional. Based on the results of the analysis, it can be observed that demographic factors significantly influence the Holland's Personality Type at the error level 0.1 and the classification accuracy is 41.7%.

Keywords – Interest, Career, Holland Theory, Personality Typology, Logistics Model.

1. Introduction

The ideology of gender is still dominating Indonesian culture and thus creates a patriarchal culture, where most of Indonesian people think that men are superior to women [1]. In Indonesian culture,

gender differences become the consideration in the distribution of work, which leads to different treatments as well. Women are usually expected to do works that require accuracy and patience, while the men are usually expected to work with physical strength [2]. Therefore, the boys are told to conform to the common standard of being manly, such as being brave and never cry, while the girls are told to be gentle and submissive. This culture is what creates differences in work between men and women [3]. Gender differences in work has negative implications, because it ignores ability of the individual [4]. Gender stereotypes related to masculinity and femininity can inhibit development, affect one's behavior and perceptions of others and raise problems of gender inequality [5], [6], [7].

Selection of career based on gender may not suit one's personality typology. This can later have a negative impact which may lead to difficulties of achieving success in their careers. However, when someone selects career in accordance with personality, in general they will be more successful in their career, because the work feels more enjoyable [8]. Suitability is what makes people more loving and happier with their work, so they can work harder and be more responsible. There is a significant relationship between personality and job satisfaction [9]. Personality typology greatly affects students' selection of interests [10]. Therefore, education has the aim to develop students' abilities and potential according to their own interests and talents. The development of students' interest and talent needs to be detected early so that the school can direct students to choose education and career path which best suit their personalities and interests. Personality is an important element in achieving one's success [11].

Holland's Personality Theory is the most widely used theory to study the phenomenon of career selection that supports individual success. Individuals who have a career that matches their personality will have a long, healthy and happy work period

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[12]. This is because people who have the same interests in the work environment will have the same personality [13]. The main focus of Holland's theory is based right on the understanding of vocational behavior to establish a practical way to help young people to start their career. Holland's types of personality are the result of the interaction of innate and environmental factors. The types are realistic, investigative, artistic, social, enterprising, and conventional [12].

The description above shows the importance of knowing students' interests in accordance with their personalities, since there are many students who change their majors after entering college because they do not feel comfortable with the major [14], [15], [16]. Therefore, the focus of this study is to analyze the career interests of high school students based on Holland's Personality Type with specific objectives: (1) Identifying the characteristics of students' career interests based on Holland's Theory; (2) Analyzing the model of student career interest development according to Holland Theory Modeling which is based on supporting demographic factors; and (3) Analyzing the accuracy of career interest classifications generated by multinomial logistics regression model.

2. Material and methodology

2.1. Types of research

The research is a quantitative research because it emphasizes on numerical data which are processed with statistical methods. The data are collected using questionnaires adopted from the Holland Personality Typology questionnaire. Each item contains questions about students' preference for certain career fields. The objective of this study is to describe the statistics and to test a (inferential) theory. Descriptive statistics are used to identify students' personality types based on Holland's theory, while inferential analysis is used to test career development models based on Holland's Personality Typology using multinomial logistics's regression analysis.

2.2. Research sites and subjects

The study was conducted in Assalaam Surakarta High School which is a formal education school in the concept of Modern Islamic Boarding School education under the Islamic Studies Council Foundation of Surakarta, with the research subjects being all Assalaam high school students in class XII in 2017/2018 academic year, which are divided into natural and social science studies majors with the number of students as many as 264 individuals.

2.3. Data collection instrument

As previously stated, the data was collected using a questionnaire adopted from the Holland Personality Typology questionnaire consisting of 48 items. Statement items are developed from 6 Holland personality types as shown in the following table (Table 1.).

Table 1. Instrument guideline

Personality Type	Item Number
Realistic	1,7,13,19,25,31,37,43
Investigative	2,8,14,20,26,32,38,44
Artistic	3,9,15,21,27,33,39,45
Social	4,10,16,22,28,34,40,46
Enterprising	5,11,17,23,29,35,41,47
Conventional	6,12,18,24,30,36,42,48
Total items	48 items

Each item is measured using a Likert scale with 5 alternative choices. The score for each answer option is as follows.

- Very Dislike = 1
- Dislike = 2
- Neutral = 3
- Like = 4
- Very Like = 5

2.4. Research variable

Apart from those data, this research also collected data from some variables which are suspected as a factor causing an individual to have a certain type of Holland personality, namely: Majors of studies (Natural science = 1 and Social science = 2); Gender (Female = 1 and Male = 2); The last education taken by father/mother (Elementary school = 1, Junior high school = 2, Senior high school = 3, Diploma = 4, Bachelor's degree = 5, Master's degree = 6); Father + mother's income per month (IDR <1 million = 1, IDR. 1-2.5 million = 2; IDR. 2.5-5 million = 3, IDR. >5 million = 4); The main occupation of parents (Civil Servant = 1; Non-Civil-Servant Lecturer / Teacher = 2; Non-Civil-Servant Doctor / Nurse = 3; Police = 4; State-Owned Enterprise employee = 5; Non-State-Owned Enterprise employee = 6; Lawyer = 7; Accountant = 8; Contractor = 9; Sailor = 11; Entrepreneur = 12; Farmer = 13; Other = 15).

2.5. Data analysis technique

The data analysis technique used was descriptive and inferential statistical analysis with multinomial logistics regression analysis. It is important to note that the response variable was nominal scale with six categories, thus the 6 categories of Y outcome variables were encoded into 0, 1, 2, 3, 4, and 5.

Furthermore, Y variable was parameterized into five logit functions. The steps in data analysis which are carried out to answer the research objectives are:

1. Perform descriptive statistical data analysis to determine the characteristics of the Holland's Personality Type of the students (respondents) which include dependent/response (Y) variables and independent/predictors variables ($X_1, X_2, X_3, X_4, X_5, X_6,$ and X_7) by looking at the frequency and percentage of each variable category.
2. Make a multinomial logistics regression model to get the factors that influence the Holland personality type of the students (respondents) using SPSS software, and the following steps.
 - a. Conduct independence test between response variables (Y) and predictor variables ($X_1, X_2, X_3, X_4, X_5, X_6,$ and X_7).
 - b. Perform individual multinomial regression analysis on the response variable (Y) with predictor variables that have a relationship with the response variable based on the independence test. In this study the categories of response variables used as comparison are conventional personality types, so that there are five logit functions, where logit function 1 is for realistic types, logit function 2 is for investigative type, logit function 3 is for artistic type, logit function 4 is for social type function and logit function 5 is for enterprising type.
 - c. Conduct simultaneous multinomial regression analysis.
 - d. Interpret the odds ratio value.
 - e. Interpret the model simultaneously and calculate the accuracy of the model classification.

2.6. Instrument validity and reliability

Proofing of instrument validity and reliability needs to be done in this study because the instrument used is an instrument adopted from the Holland's Personality Typology questionnaire. The validity measured in this study is content validity. The measurement of content validity is conducted using the Lawshe's Content Validity Ratio (CVR) method. This study involved 7 people as raters by choosing one of 3 answers, namely: accepted, accepted with review and rejected. If the obtained CVR coefficient/index is greater than the CVR minimum value thus the question item used has fulfilled the validity of the content (valid). After revising several times, there were 48 items which were valid.

Instrument reliability was measured by following the Alpha Cronbach coefficient concept on six

personality type constructs. Instrument reliability was analyzed using SPSS software by calculating the instrument reliability partially and completely using Cronbach Alpha. Each construct was said to be reliable with an Alpha coefficient of at least 0,7. Details of the reliability analysis results of each construct are as in Table 2.

Table 2. Reliability of each construct

Construct	Variance	Coefficient Alpha	Criteria
Realistic	36.596	0.798	Reliable
Investigative	51.398	0.832	Reliable
Artistic	42.852	0.763	Reliable
Social	29.169	0.701	Reliable
Enterprising	31.338	0.729	Reliable
Conventional	46.981	0.842	Reliable
Overall	563.688		

To calculate the overall (total) reliability using the following formula:

$$\alpha_{strat} = 1 - \frac{\sum \sigma_i^2 (1 - \alpha_i)}{\sigma_x^2} \tag{7}$$

$$\alpha_{strat} = 1 - \left(\frac{36.596(1-.798) + 51.398(1-.83) + 42.85(1-.76) + 29.169(1-.70) + 31.338(1-.729) + 46.98(1-.84)}{563.688} \right)$$

$$\alpha_{strat} = 0.9099$$

From the calculation of overall reliability, it is showed that the overall reliability of the construct has a reliability level of 0.9099, thus the instrument is categorized as reliable.

3. Result and discussion

3.1 Characteristics of high school students

The categories of characteristics were based on Holland's Personality Type, which are majors of studies in high school, student's gender, father's education, mother's education, parent's income, father's occupation, and mother's occupation.

Based on Table 3., it can be seen that the majority of respondents have enterprising and artistic personality types, consecutively as much as 24.2% and 22%. The enterprising type prefers activities that involve manipulation of others for financial (economic) benefits, the success in politics and economics. Meanwhile, people of artistic type prefer activities that are diverse, free, and not systematized to create artistic products, such as paintings, dramas, proses and do not like systematic, regular and routine activities.

Besides the information regarding the characteristics of respondents which is based on personality types in Table 3., the data processing using SPSS also obtained information on the characteristics of other respondents. Mostly, the

respondents were nature science major students, whose percentage was 69.7%. In terms of gender, the percentage was approximately equal, the female respondents amounted to 59.8% and the male respondents to 40.2%. Most of the respondents' fathers' educational background were Bachelors degree, which amounted to 43.2%, and most of the mothers' educational background were bachelor's degree and senior high school both at 39.4% . In terms of parent's income, 50% of the respondents' parents had relatively high monthly income, which were IDR. 5 million. Such high income was related to fathers' occupation variable, of which the majority was entrepreneur by 39.4%. Most of mothers' occupations were housewives by 43.9%.

Table 3. Characteristics of respondents

Personality Type	Percentage
Realistic	3.8%
Investigative	13.6%
Artistic	22.0%
Social	18.9%
Enterprising	24.2%
Conventional	17.4%

After the characteristics of the respondents were gained, the next step was to conduct independence test between the independent/predictors variables (X) and the dependent/response variables (Y) to find out the relationship between these variables. Then, cross tabulation was employed between the response variables and the predictor variables. The hypotheses used to test the independence between the predictor variables and the response variables were as follows.

H₀: there is no relationship between predictor variables and response variables

H₁: there is a relationship between predictor variables and response variables

The research used the Chi-square test statistic. The test results are shown in Table 4.

Table 4. Independence test between response and predictor variable

Variable	Chi-Square Value	P-Value (Sig.)	Decision
Major of Studies	24.076	0.000	Reject H ₀
Gender	23.793	0.000	Reject H ₀
Father's Education	80.959	0.000	Reject H ₀
Mother's Education	72.411	0.000	Reject H ₀
Parent's Income	24.914	0.050	Reject H ₀
Father's occupation	156.259	0.000	Reject H ₀
Mother's occupation	58.287	0.001	Reject H ₀

Based on Table 4. it is known that all the predictor variables which have relationship with the response

variable Holland's Personality Type (Y), were the variable of Major of Studies (X₁), Gender (X₂), Father Educational Background (X₃), Mother Educational Background (X₄), Parent's Income (X₅), Father's Occupation (X₆) and Mother's Occupation (X₇).

3.2 Holland's Personality Type Model

In order to determine the factors that influence Holland's personality type, this research employed multinomial logistics regression method because the response variables have nominal data scale consisting of six categories. These six categories were response variables in this multinomial logistics regression method, while the predictor variables were those that have relationship with Holland's Personality Type response variables (Y), namely Major of Studies (X₁), Gender (X₂), Father Educational Background (X₃), Mother Educational Background (X₄), Parent's Income (X₅), Father's Occupation (X₆) and Mother's Occupation (X₇).

Individual multinomial logistics regression includes individual parameter testing and parameter estimation. Using the Wald test, this research conducted individual testing to determine the significance of predictor variable parameters. If the parameter of a predictor variable was significant, thus the predictor variable would affect response variables. The hypotheses were as follows.

$$H_0 : \beta_k = 0$$

$$H_1 : \beta_k \neq 0, \text{ where } k = 1, 2.. p$$

This study used Wald test statistics. Using the comparison category, which was the conventional personality type, the analysis obtained the results as shown in Table 5.

Table 5. Individual predictor variable test

Variable	Chi-Square Value	P-Value (Sig.)
Major of Studies	33.879	0.0001
Gender	24.277	0.0001
Father's Education	85.533	0.0001
Mother's Education	79.207	0.0001
Parent's Income	28.323	0.0200
Father's occupation	140.057	0.0001
Mother's occupation	63.066	0.0001

Table 5. shows that the variables used in individual multinomial logistics regression testing which are the variables of Major of Studies (X₁), Gender (X₂), Father Educational Background (X₃), Mother Educational Background (X₄), Parent's Income (X₅), Father's Occupation (X₆) and Mother's Occupation (X₇) significantly influenced the Holland's Personality Type (Y). That was indicated

by the p-value (sig.) in each predictor variable which was less than α , where α is at 0.1. Based on the results of data processing with the help of SPSS, the response probability function or multinomial logistics regression model for Senior High School Major of Studies predictor variables (X_1) was related to the equation (8), (9), (10), (11) and (12) with the logit function as follows with conventional category as comparison.

Model for realistic type
 $g_1(X_1) = -1.386 - 0.560 X_1(1)$ (8)

Model for investigative type
 $g_2(X_1) = 0.118 - 21.486 X_1(1)$ (9)

Model for artistic type
 $g_3(X_1) = 0.172 + 0.185 X_1(1)$ (10)

Model for social type
 $g_4(X_1) = -0.208 + 0.747 X_1(1)$ (11)

Model for enterprising type
 $g_5(X_1) = 0.318 + 0.038 X_1(1)$ (12)

After individual multinomial logistics regression was carried out, and predictor variables that significantly influenced the response variables had been obtained, Likelihood Ratio Test was carried out simultaneously to obtain predictor variables that simultaneously affected the response variables. The hypotheses in simultaneous testing are as follows.

$H_0 : \beta_1 = \beta_2 = \dots = \beta_p = 0$

$H_1 : \text{at least there is one } \beta_k \neq 0,$

where $k = 1, 2, \dots, p$

Table 6. Simultaneous testing of predictor's variable

Effect	Likelihood Ratio Tests		
	Chi-Square	Df	P-Value (Sig.)
Intercept	14.777	5	0.011
Department	27.940	5	0.000
Gender	9.552	5	0.089
Father's education	19.521	5	0.002
Mother's education	28.045	5	0.000
Parent's income	16.382	5	0.006
Father's occupation	9.628	5	0.086
Mother's occupation	9.005	5	0.100

Based on Table 6., Study Major (X_1), Gender (X_2), Father's Education (X_3), Mother's Education (X_4), Parents' Income (X_5), Father's Occupation (X_6) and Mother's Occupation (X_7) variables simultaneously have a significant effect on the

response. The parameter estimates of the simultaneous testing are shown in Table 6.

Based on the results of data processing with SPSS, the odds ratio in logit 1 can be seen (realistic personality type):

1. For the social studies category, the value is 0.338, which means that respondents from social science major have a chance 0.338 times bigger to have realistic personality types compared with respondents from science majors with assumption that other variables are constant.
2. The tendency of female respondents is 0.265 times more likely to have realistic personality type compared to male respondents with assumptions that the other variables are constant.
3. Respondents who have a father with a primary education are 71.361 times more likely to have a realistic personality type compared to the respondents with a father with other categories of education assuming other variables are constant. The tendency of respondents who have a father with a junior high school education to have a realistic personality type is 61.350 times more than the respondent with a father with other categories of education assuming other variables are constant. The tendency of respondents who have a father with a high school education to have a realistic personality type is 130.227 times bigger than the respondent with a father with other categories of education assuming other variables are constant. The tendency of respondents who have a father with a D3 final education to have a realistic personality type is 0.580 times more than the respondents with a father with other categories of education assuming other variables are constant. The tendency of respondents who have a father with a final education bachelor's degree to have a realistic personality type is 2.359 times higher than the respondent with a father with other categories of education assuming other variables are constant.
4. The tendency of respondents who have a primary school-educated mother to have a realistic personality type is 0.007 times greater than the respondents with mothers with other categories of education assuming other variables are constant. The tendency of respondents who have a junior high school-educated mother to have a realistic personality type is 0.017 times greater than the respondents with mothers with other categories of education assuming other variables are constant. The tendency of respondents who have a high school-educated mother to have a realistic personality type is 0.105 times greater than the respondents with a mother with other categories of education assuming other variables are

constant. The tendency of respondents who have a diploma-educated mother to have a realistic personality type is 0.027 times greater than the respondents with a mother with other categories of education assuming other variables are constant. The tendency of respondents, who have bachelor's degree-educated mother, to have a realistic personality type is 0.190 times greater than the respondents with mothers from other categories of education assuming other variables are constant.

5. Respondents who have parents with income less than IDR. 1 million is 0.548 times more likely to have a realistic personality type than the respondents who have parents with other categories of income assuming other variables are constant. Respondents who have parents with income of IDR. 1 Million to IDR. 2.5 Million is 61.544 times more likely to have a realistic personality type than the respondents who have parents with other categories of income assuming other variables are constant. Respondents who have parents with income of IDR. 2.5 Million to IDR. 5 Million is 5.329 times more likely to have a realistic personality type than the respondents who have parents with other categories of income assuming other variables are constant.
6. The tendency of respondents whose fathers are civil servants to have realistic personality types is 81.410 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are lecturers / teachers to have realistic personality type is 9.076 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are doctors / nurses to have realistic personality type is 81.149 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are police to have a realistic personality type is 13933.887 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are state-owned company employees to have realistic personality type is 24.385 times higher than respondents with fathers with other profession assuming other variables are constant. The tendency of respondents whose fathers are private employees to have realistic personality types is 5420.849 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers were lawyers to have realistic personality types was 1078.468 times higher than respondents

- with fathers with other professions assuming other variables were constant. The tendency of respondents whose fathers are accountants to have realistic personality types was 53.316 times higher than respondents with fathers with other profession assuming other variables were constant. The tendency of respondents whose fathers are contractors to have realistic personality types is 2.258×10^{302} times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are flight attendants to have realistic personality type is 3226.403 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are sailors to have realistic personality type, was 18031.582 times higher than respondents with fathers with other profession assuming other variables were constant. The tendency of respondents whose fathers are self-employed to have realistic personality type is 8.338 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are farmers to have realistic personality type is 0.224 times higher than respondents with fathers with other professions assuming other variables are constant.
7. The tendency of respondents whose mothers are civil servants to have a realistic personality type is 0.031 times higher than the respondents with other professions with the assumption that other variables are constant. The tendency of respondents whose mothers are doctors / nurses to have realistic personality type is 0.357 times higher than respondents with mothers of other professions assuming other variables are constant. The tendency of respondents whose mothers are state-owned company employees to have realistic personality types is 0.166 times higher than respondents with other profession mothers assuming other variables are constant. The tendency of respondents whose mothers are private employees to have personality types realistic is 0.920 times higher than respondents with other professionals with the assumption that other variables are constant. The tendency of respondents whose mothers are self-employed to have a realistic personality type is 0.132 times higher than the respondents with other professions with the assumption that other variables are constant. The tendency of respondents whose mothers are housewives to have realistic personality types was 0.010 times higher than respondents with mothers of other professions assuming other variables were constant.

The simultaneous probability function or multinomial logistics regression function resulting from parameter estimates that have been carried out is in accordance with equations (8), (9), (10), (11) and (12) with the logit function as follows.

Models for realistic types:

$$g_1(X_1) = -1.218 - 1.086 X_1(1) - 1.329 X_2(1) + 4.268 X_3(1) + 4.117 X_3(2) + 4.869 X_3(3) - 0.545 X_3(4) + 0.932 X_3(5) - 5.017 X_4(1) - 4.081 X_4(2) - 2.258 X_4(3) - 3.602 X_4(4) - 1.661 X_4(5) - 0.602 X_5(1) + 4.120 X_5(2) + 1.673 X_5(3) + 4.400 X_6(1) + 2.206 X_6(2) + 4.396 X_6(3) + 9.542 X_6(4) + 3.194 X_6(5) + 8.598 X_6(6) + 6.983 X_6(7) + 3.976 X_6(8) + 696.195 X_6(9) + 8.079 X_6(10) + 9.800 X_6(11) + 2.121 X_6(12) - 1.497 X_6(13) - 3.486 X_7(1) - 1.030 X_7(3) - 1.794 X_7(5) - 0.084 X_7(6) - 2.023 X_7(12) - 4.631 X_7(14)$$

in the same way, a model for investigative, artistic, social and enterprising types will be obtained.

3.3 Accuracy of model classification

The accuracy of the classification obtained from the model is shown in Table 7. Table 7. shows that the classification accuracy of the model is 41.7%. It shows that the number of predictions which matched the actual conditions (observation) was 41.7%. It also shows that the misclassification was 58.3%. It can be observed in Table 7. that 20% of realistic type respondents was correctly predicted by the model so that there are as many as 80% respondents belonged to realistic type categories who were misclassified into other categories. Based on the observation, 61.1% of the investigative type respondents were correctly predicted by the model so that there are as many as 38.9% of investigative type respondents who were misclassified into other categories. Based on the observation, the model correctly predicted 31% of the artistic type respondents. Therefore, there were 69% of the artistic type category respondents who were incorrectly classified into other categories. Based on the observation, 36% of the social type respondents were correctly predicted by the model so that there are as many as 64% of the social type categories who were incorrectly classified into other categories. The model correctly predicted 65.5% of the enterprising type respondents. Therefore, there were 34.4% of enterprising type categories which were classified into other categories. Finally, 17.4% conventional type respondents were correctly predicted by the model so that there were 82.6% conventional type respondents who were misclassified into other categories.

Table 6. Accuracy of model classification

Observed	Predicted						Correct
	R	I	A	S	E	C	
R	2	0	4	0	4	0	20.0%
I	0	22	6	0	6	2	61.1%
A	0	10	18	16	12	2	31.0%
S	0	6	10	18	14	2	36.0%
E	0	8	8	4	42	2	65.6%
C	0	0	10	10	18	8	17.4%
Overall	0.8 %	17.4 %	21.2 %	18.2 %	36.4 %	6.1 %	41.7 %

Although the overall parameters are significant at error level (α) 0.1, the classification accuracy is less than 50 %. This may be caused by the lack of representative predictor variables for modelling the Holland Personality Type or inappropriate selection of model.

4. Conclusion

Based on data analysis and discussion, it was concluded that the majority of respondents were classified into enterprising (24.2%) and artistic (22%) personality types. Most respondents (69.7%) were from science majors. The proportion of gender was approximately the same; 59.8% of the students were female and 40.2% were male. Most of the respondents' fathers were graduated with bachelor's degree (43.2%), while the mothers were majority bachelor's degree and senior high school graduates with the same percentage of 39.4%. Regarding the parents' income, 50% of respondents' parents had high monthly income of above IDR. 5 million. The high income was dominantly obtained from respondents whose fathers were entrepreneurs (39.4%) while the mothers were mostly housewives (43.9%).

Based on the individual multinomial logistics regression test, it could be observed that all predictor variables, namely, Major of studies (X_1), Gender (X_2), Father's Education (X_3), Mother's Education (X_4), Parent's Income (X_5), Father's Occupation (X_6) and Mother's Occupation (X_7) significantly influence the Holland Personality Type (Y) at the error level (α) 0.1.

Multinomial logistics regression model for Holland student personality type resulted in classification accuracy of only 41.7%. The low accuracy of classification may be due to a lack of predictor variables that were representative for modelling the students' Holland Personality Type or due to less appropriate selection of a model.

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Detection of Students' Interest With the Logistics Model

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Abstract – The focus of this research is to analyze the model that classifies student personality type based on demographic factors. This model can identify students' career interests. It is important to know students' career interest in accordance with their personalities. For the analysis method, the researchers applied multinomial logistics regression analysis with consideration to the nominal data scale of Holland's Personality Types, namely realistic, investigative, artistic, social, enterprising, and conventional. Based on the results of the analysis, it can be observed that demographic factors significantly influence the Holland's Personality Type at the error level 0.1 and the classification accuracy is 41.7%.

Keywords – Interest, Career, Holland Theory, Personality Typology, Logistics Model.

1. Introduction

The ideology of gender is still dominating Indonesian culture and thus creates a patriarchal culture, where most of Indonesian people think that men are superior to women [1]. In Indonesian culture,

gender differences become the consideration in the distribution of work, which leads to different treatments as well. Women are usually expected to do works that require accuracy and patience, while the men are usually expected to work with physical strength [2]. Therefore, the boys are told to conform to the common standard of being manly, such as being brave and never cry, while the girls are told to be gentle and submissive. This culture is what creates differences in work between men and women [3]. Gender differences in work has negative implications, because it ignores ability of the individual [4]. Gender stereotypes related to masculinity and femininity can inhibit development, affect one's behavior and perceptions of others and raise problems of gender inequality [5], [6], [7].

Selection of career based on gender may not suit one's personality typology. This can later have a negative impact which may lead to difficulties of achieving success in their careers. However, when someone selects career in accordance with personality, in general they will be more successful in their career, because the work feels more enjoyable [8]. Suitability is what makes people more loving and happier with their work, so they can work harder and be more responsible. There is a significant relationship between personality and job satisfaction [9]. Personality typology greatly affects students' selection of interests [10]. Therefore, education has the aim to develop students' abilities and potential according to their own interests and talents. The development of students' interest and talent needs to be detected early so that the school can direct students to choose education and career path which best suit their personalities and interests. Personality is an important element in achieving one's success [11].

Holland's Personality Theory is the most widely used theory to study the phenomenon of career selection that supports individual success. Individuals who have a career that matches their personality will have a long, healthy and happy work period

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[12]. This is because people who have the same interests in the work environment will have the same personality [13]. The main focus of Holland's theory is based right on the understanding of vocational behavior to establish a practical way to help young people to start their career. Holland's types of personality are the result of the interaction of innate and environmental factors. The types are realistic, investigative, artistic, social, enterprising, and conventional [12].

The description above shows the importance of knowing students' interests in accordance with their personalities, since there are many students who change their majors after entering college because they do not feel comfortable with the major [14], [15], [16]. Therefore, the focus of this study is to analyze the career interests of high school students based on Holland's Personality Type with specific objectives: (1) Identifying the characteristics of students' career interests based on Holland's Theory; (2) Analyzing the model of student career interest development according to Holland Theory Modeling which is based on supporting demographic factors; and (3) Analyzing the accuracy of career interest classifications generated by multinomial logistics regression model.

2. Material and methodology

2.1. Types of research

The research is a quantitative research because it emphasizes on numerical data which are processed with statistical methods. The data are collected using questionnaires adopted from the Holland Personality Typology questionnaire. Each item contains questions about students' preference for certain career fields. The objective of this study is to describe the statistics and to test a (inferential) theory. Descriptive statistics are used to identify students' personality types based on Holland's theory, while inferential analysis is used to test career development models based on Holland's Personality Typology using multinomial logistics's regression analysis.

2.2. Research sites and subjects

The study was conducted in Assalaam Surakarta High School which is a formal education school in the concept of Modern Islamic Boarding School education under the Islamic Studies Council Foundation of Surakarta, with the research subjects being all Assalaam high school students in class XII in 2017/2018 academic year, which are divided into natural and social science studies majors with the number of students as many as 264 individuals.

2.3. Data collection instrument

As previously stated, the data was collected using a questionnaire adopted from the Holland Personality Typology questionnaire consisting of 48 items. Statement items are developed from 6 Holland personality types as shown in the following table (Table 1.).

Table 1. Instrument guideline

Personality Type	Item Number
Realistic	1,7,13,19,25,31,37,43
Investigative	2,8,14,20,26,32,38,44
Artistic	3,9,15,21,27,33,39,45
Social	4,10,16,22,28,34,40,46
Enterprising	5,11,17,23,29,35,41,47
Conventional	6,12,18,24,30,36,42,48
Total items	48 items

Each item is measured using a Likert scale with 5 alternative choices. The score for each answer option is as follows.

- Very Dislike = 1
- Dislike = 2
- Neutral = 3
- Like = 4
- Very Like = 5

2.4. Research variable

Apart from those data, this research also collected data from some variables which are suspected as a factor causing an individual to have a certain type of Holland personality, namely: Majors of studies (Natural science = 1 and Social science = 2); Gender (Female = 1 and Male = 2); The last education taken by father/mother (Elementary school = 1, Junior high school = 2, Senior high school = 3, Diploma = 4, Bachelor's degree = 5, Master's degree = 6); Father + mother's income per month (IDR <1 million = 1, IDR. 1-2.5 million = 2; IDR. 2.5-5 million = 3, IDR. >5 million = 4); The main occupation of parents (Civil Servant = 1; Non-Civil-Servant Lecturer / Teacher = 2; Non-Civil-Servant Doctor / Nurse = 3; Police = 4; State-Owned Enterprise employee = 5; Non-State-Owned Enterprise employee = 6; Lawyer = 7; Accountant = 8; Contractor = 9; Sailor = 11; Entrepreneur = 12; Farmer = 13; Other = 15).

2.5. Data analysis technique

The data analysis technique used was descriptive and inferential statistical analysis with multinomial logistics regression analysis. It is important to note that the response variable was nominal scale with six categories, thus the 6 categories of Y outcome variables were encoded into 0, 1, 2, 3, 4, and 5.

Furthermore, Y variable was parameterized into five logit functions. The steps in data analysis which are carried out to answer the research objectives are:

1. Perform descriptive statistical data analysis to determine the characteristics of the Holland's Personality Type of the students (respondents) which include dependent/response (Y) variables and independent/predictors variables ($X_1, X_2, X_3, X_4, X_5, X_6,$ and X_7) by looking at the frequency and percentage of each variable category.
2. Make a multinomial logistics regression model to get the factors that influence the Holland personality type of the students (respondents) using SPSS software, and the following steps.
 - a. Conduct independence test between response variables (Y) and predictor variables ($X_1, X_2, X_3, X_4, X_5, X_6,$ and X_7).
 - b. Perform individual multinomial regression analysis on the response variable (Y) with predictor variables that have a relationship with the response variable based on the independence test. In this study the categories of response variables used as comparison are conventional personality types, so that there are five logit functions, where logit function 1 is for realistic types, logit function 2 is for investigative type, logit function 3 is for artistic type, logit function 4 is for social type function and logit function 5 is for enterprising type.
 - c. Conduct simultaneous multinomial regression analysis.
 - d. Interpret the odds ratio value.
 - e. Interpret the model simultaneously and calculate the accuracy of the model classification.

2.6. Instrument validity and reliability

Proofing of instrument validity and reliability needs to be done in this study because the instrument used is an instrument adopted from the Holland's Personality Typology questionnaire. The validity measured in this study is content validity. The measurement of content validity is conducted using the Lawshe's Content Validity Ratio (CVR) method. This study involved 7 people as raters by choosing one of 3 answers, namely: accepted, accepted with review and rejected. If the obtained CVR coefficient/index is greater than the CVR minimum value thus the question item used has fulfilled the validity of the content (valid). After revising several times, there were 48 items which were valid.

Instrument reliability was measured by following the Alpha Cronbach coefficient concept on six

personality type constructs. Instrument reliability was analyzed using SPSS software by calculating the instrument reliability partially and completely using Cronbach Alpha. Each construct was said to be reliable with an Alpha coefficient of at least 0,7. Details of the reliability analysis results of each construct are as in Table 2.

Table 2. Reliability of each construct

Construct	Variance	Coefficient Alpha	Criteria
Realistic	36.596	0.798	Reliable
Investigative	51.398	0.832	Reliable
Artistic	42.852	0.763	Reliable
Social	29.169	0.701	Reliable
Enterprising	31.338	0.729	Reliable
Conventional	46.981	0.842	Reliable
Overall	563.688		

To calculate the overall (total) reliability using the following formula:

$$\alpha_{strat} = 1 - \frac{\sum \sigma_i^2 (1 - \alpha_i)}{\sigma_x^2} \tag{7}$$

$$\alpha_{strat} = 1 - \left(\frac{36.596(1-.798) + 51.398(1-.83) + 42.85(1-.76) + 29.169(1-.70) + 31.338(1-.729) + 46.98(1-.84)}{563.688} \right)$$

$$\alpha_{strat} = 0.9099$$

From the calculation of overall reliability, it is showed that the overall reliability of the construct has a reliability level of 0.9099, thus the instrument is categorized as reliable.

3. Result and discussion

3.1 Characteristics of high school students

The categories of characteristics were based on Holland's Personality Type, which are majors of studies in high school, student's gender, father's education, mother's education, parent's income, father's occupation, and mother's occupation.

Based on Table 3., it can be seen that the majority of respondents have enterprising and artistic personality types, consecutively as much as 24.2% and 22%. The enterprising type prefers activities that involve manipulation of others for financial (economic) benefits, the success in politics and economics. Meanwhile, people of artistic type prefer activities that are diverse, free, and not systematized to create artistic products, such as paintings, dramas, proses and do not like systematic, regular and routine activities.

Besides the information regarding the characteristics of respondents which is based on personality types in Table 3., the data processing using SPSS also obtained information on the characteristics of other respondents. Mostly, the

respondents were nature science major students, whose percentage was 69.7%. In terms of gender, the percentage was approximately equal, the female respondents amounted to 59.8% and the male respondents to 40.2%. Most of the respondents' fathers' educational background were Bachelors degree, which amounted to 43.2%, and most of the mothers' educational background were bachelor's degree and senior high school both at 39.4% . In terms of parent's income, 50% of the respondents' parents had relatively high monthly income, which were IDR. 5 million. Such high income was related to fathers' occupation variable, of which the majority was entrepreneur by 39.4%. Most of mothers' occupations were housewives by 43.9%.

Table 3. Characteristics of respondents

Personality Type	Percentage
Realistic	3.8%
Investigative	13.6%
Artistic	22.0%
Social	18.9%
Enterprising	24.2%
Conventional	17.4%

After the characteristics of the respondents were gained, the next step was to conduct independence test between the independent/predictors variables (X) and the dependent/response variables (Y) to find out the relationship between these variables. Then, cross tabulation was employed between the response variables and the predictor variables. The hypotheses used to test the independence between the predictor variables and the response variables were as follows.

H₀: there is no relationship between predictor variables and response variables

H₁: there is a relationship between predictor variables and response variables

The research used the Chi-square test statistic. The test results are shown in Table 4.

Table 4. Independence test between response and predictor variable

Variable	Chi-Square Value	P-Value (Sig.)	Decision
Major of Studies	24.076	0.000	Reject H ₀
Gender	23.793	0.000	Reject H ₀
Father's Education	80.959	0.000	Reject H ₀
Mother's Education	72.411	0.000	Reject H ₀
Parent's Income	24.914	0.050	Reject H ₀
Father's occupation	156.259	0.000	Reject H ₀
Mother's occupation	58.287	0.001	Reject H ₀

Based on Table 4. it is known that all the predictor variables which have relationship with the response

variable Holland's Personality Type (Y), were the variable of Major of Studies (X₁), Gender (X₂), Father Educational Background (X₃), Mother Educational Background (X₄), Parent's Income (X₅), Father's Occupation (X₆) and Mother's Occupation (X₇).

3.2 Holland's Personality Type Model

In order to determine the factors that influence Holland's personality type, this research employed multinomial logistics regression method because the response variables have nominal data scale consisting of six categories. These six categories were response variables in this multinomial logistics regression method, while the predictor variables were those that have relationship with Holland's Personality Type response variables (Y), namely Major of Studies (X₁), Gender (X₂), Father Educational Background (X₃), Mother Educational Background (X₄), Parent's Income (X₅), Father's Occupation (X₆) and Mother's Occupation (X₇).

Individual multinomial logistics regression includes individual parameter testing and parameter estimation. Using the Wald test, this research conducted individual testing to determine the significance of predictor variable parameters. If the parameter of a predictor variable was significant, thus the predictor variable would affect response variables. The hypotheses were as follows.

$$H_0 : \beta_k = 0$$

$$H_1 : \beta_k \neq 0, \text{ where } k = 1, 2.. p$$

This study used Wald test statistics. Using the comparison category, which was the conventional personality type, the analysis obtained the results as shown in Table 5.

Table 5. Individual predictor variable test

Variable	Chi-Square Value	P-Value (Sig.)
Major of Studies	33.879	0.0001
Gender	24.277	0.0001
Father's Education	85.533	0.0001
Mother's Education	79.207	0.0001
Parent's Income	28.323	0.0200
Father's occupation	140.057	0.0001
Mother's occupation	63.066	0.0001

Table 5. shows that the variables used in individual multinomial logistics regression testing which are the variables of Major of Studies (X₁), Gender (X₂), Father Educational Background (X₃), Mother Educational Background (X₄), Parent's Income (X₅), Father's Occupation (X₆) and Mother's Occupation (X₇) significantly influenced the Holland's Personality Type (Y). That was indicated

by the p-value (sig.) in each predictor variable which was less than α , where α is at 0.1. Based on the results of data processing with the help of SPSS, the response probability function or multinomial logistics regression model for Senior High School Major of Studies predictor variables (X_1) was related to the equation (8), (9), (10), (11) and (12) with the logit function as follows with conventional category as comparison.

$$\text{Model for realistic type} \\ g_1(X_1) = -1.386 - 0.560 X_1(1) \quad (8)$$

$$\text{Model for investigative type} \\ g_2(X_1) = 0.118 - 21.486 X_1(1) \quad (9)$$

$$\text{Model for artistic type} \\ g_3(X_1) = 0.172 + 0.185 X_1(1) \quad (10)$$

$$\text{Model for social type} \\ g_4(X_1) = -0.208 + 0.747 X_1(1) \quad (11)$$

$$\text{Model for enterprising type} \\ g_5(X_1) = 0.318 + 0.038 X_1(1) \quad (12)$$

After individual multinomial logistics regression was carried out, and predictor variables that significantly influenced the response variables had been obtained, Likelihood Ratio Test was carried out simultaneously to obtain predictor variables that simultaneously affected the response variables. The hypotheses in simultaneous testing are as follows.

$$H_0 : \beta_1 = \beta_2 = \dots = \beta_p = 0$$

$$H_1 : \text{at least there is one } \beta_k \neq 0,$$

where $k = 1, 2, \dots, p$

Table 6. Simultaneous testing of predictor's variable

Effect	Likelihood Ratio Tests		
	Chi-Square	Df	P-Value (Sig.)
Intercept	14.777	5	0.011
Department	27.940	5	0.000
Gender	9.552	5	0.089
Father's education	19.521	5	0.002
Mother's education	28.045	5	0.000
Parent's income	16.382	5	0.006
Father's occupation	9.628	5	0.086
Mother's occupation	9.005	5	0.100

Based on Table 6., Study Major (X_1), Gender (X_2), Father's Education (X_3), Mother's Education (X_4), Parents' Income (X_5), Father's Occupation (X_6) and Mother's Occupation (X_7) variables simultaneously have a significant effect on the

response. The parameter estimates of the simultaneous testing are shown in Table 6.

Based on the results of data processing with SPSS, the odds ratio in logit 1 can be seen (realistic personality type):

1. For the social studies category, the value is 0.338, which means that respondents from social science major have a chance 0.338 times bigger to have realistic personality types compared with respondents from science majors with assumption that other variables are constant.
2. The tendency of female respondents is 0.265 times more likely to have realistic personality type compared to male respondents with assumptions that the other variables are constant.
3. Respondents who have a father with a primary education are 71.361 times more likely to have a realistic personality type compared to the respondents with a father with other categories of education assuming other variables are constant. The tendency of respondents who have a father with a junior high school education to have a realistic personality type is 61.350 times more than the respondent with a father with other categories of education assuming other variables are constant. The tendency of respondents who have a father with a high school education to have a realistic personality type is 130.227 times bigger than the respondent with a father with other categories of education assuming other variables are constant. The tendency of respondents who have a father with a D3 final education to have a realistic personality type is 0.580 times more than the respondents with a father with other categories of education assuming other variables are constant. The tendency of respondents who have a father with a final education bachelor's degree to have a realistic personality type is 2.359 times higher than the respondent with a father with other categories of education assuming other variables are constant.
4. The tendency of respondents who have a primary school-educated mother to have a realistic personality type is 0.007 times greater than the respondents with mothers with other categories of education assuming other variables are constant. The tendency of respondents who have a junior high school-educated mother to have a realistic personality type is 0.017 times greater than the respondents with mothers with other categories of education assuming other variables are constant. The tendency of respondents who have a high school-educated mother to have a realistic personality type is 0.105 times greater than the respondents with a mother with other categories of education assuming other variables are

constant. The tendency of respondents who have a diploma-educated mother to have a realistic personality type is 0.027 times greater than the respondents with a mother with other categories of education assuming other variables are constant. The tendency of respondents, who have bachelor's degree-educated mother, to have a realistic personality type is 0.190 times greater than the respondents with mothers from other categories of education assuming other variables are constant.

5. Respondents who have parents with income less than IDR. 1 million is 0.548 times more likely to have a realistic personality type than the respondents who have parents with other categories of income assuming other variables are constant. Respondents who have parents with income of IDR. 1 Million to IDR. 2.5 Million is 61.544 times more likely to have a realistic personality type than the respondents who have parents with other categories of income assuming other variables are constant. Respondents who have parents with income of IDR. 2.5 Million to IDR. 5 Million is 5.329 times more likely to have a realistic personality type than the respondents who have parents with other categories of income assuming other variables are constant.
6. The tendency of respondents whose fathers are civil servants to have realistic personality types is 81.410 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are lecturers / teachers to have realistic personality type is 9.076 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are doctors / nurses to have realistic personality type is 81.149 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are police to have a realistic personality type is 13933.887 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are state-owned company employees to have realistic personality type is 24.385 times higher than respondents with fathers with other profession assuming other variables are constant. The tendency of respondents whose fathers are private employees to have realistic personality types is 5420.849 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers were lawyers to have realistic personality types was 1078.468 times higher than respondents with fathers with other professions assuming other variables were constant. The tendency of respondents whose fathers are accountants to have realistic personality types was 53.316 times higher than respondents with fathers with other profession assuming other variables were constant. The tendency of respondents whose fathers are contractors to have realistic personality types is 2.258×10^{302} times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are flight attendants to have realistic personality type is 3226.403 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are sailors to have realistic personality type, was 18031.582 times higher than respondents with fathers with other profession assuming other variables were constant. The tendency of respondents whose fathers are self-employed to have realistic personality type is 8.338 times higher than respondents with fathers with other professions assuming other variables are constant. The tendency of respondents whose fathers are farmers to have realistic personality type is 0.224 times higher than respondents with fathers with other professions assuming other variables are constant.
7. The tendency of respondents whose mothers are civil servants to have a realistic personality type is 0.031 times higher than the respondents with other professions with the assumption that other variables are constant. The tendency of respondents whose mothers are doctors / nurses to have realistic personality type is 0.357 times higher than respondents with mothers of other professions assuming other variables are constant. The tendency of respondents whose mothers are state-owned company employees to have realistic personality types is 0.166 times higher than respondents with other profession mothers assuming other variables are constant. The tendency of respondents whose mothers are private employees to have personality types realistic is 0.920 times higher than respondents with other professionals with the assumption that other variables are constant. The tendency of respondents whose mothers are self-employed to have a realistic personality type is 0.132 times higher than the respondents with other professions with the assumption that other variables are constant. The tendency of respondents whose mothers are housewives to have realistic personality types was 0.010 times higher than respondents with mothers of other professions assuming other variables were constant.

The simultaneous probability function or multinomial logistics regression function resulting from parameter estimates that have been carried out is in accordance with equations (8), (9), (10), (11) and (12) with the logit function as follows.

Models for realistic types:

$$g_1(X_1) = -1.218 - 1.086 X_1(1) - 1.329 X_2(1) + 4.268 X_3(1) + 4.117 X_3(2) + 4.869 X_3(3) - 0.545 X_3(4) + 0.932 X_3(5) - 5.017 X_4(1) - 4.081 X_4(2) - 2.258 X_4(3) - 3.602 X_4(4) - 1.661 X_4(5) - 0.602 X_5(1) + 4.120 X_5(2) + 1.673 X_5(3) + 4.400 X_6(1) + 2.206 X_6(2) + 4.396 X_6(3) + 9.542 X_6(4) + 3.194 X_6(5) + 8.598 X_6(6) + 6.983 X_6(7) + 3.976 X_6(8) + 696.195 X_6(9) + 8.079 X_6(10) + 9.800 X_6(11) + 2.121 X_6(12) - 1.497 X_6(13) - 3.486 X_7(1) - 1.030 X_7(3) - 1.794 X_7(5) - 0.084 X_7(6) - 2.023 X_7(12) - 4.631 X_7(14)$$

in the same way, a model for investigative, artistic, social and enterprising types will be obtained.

3.3 Accuracy of model classification

The accuracy of the classification obtained from the model is shown in Table 7. Table 7. shows that the classification accuracy of the model is 41.7%. It shows that the number of predictions which matched the actual conditions (observation) was 41.7%. It also shows that the misclassification was 58.3%. It can be observed in Table 7. that 20% of realistic type respondents was correctly predicted by the model so that there are as many as 80% respondents belonged to realistic type categories who were misclassified into other categories. Based on the observation, 61.1% of the investigative type respondents were correctly predicted by the model so that there are as many as 38.9% of investigative type respondents who were misclassified into other categories. Based on the observation, the model correctly predicted 31% of the artistic type respondents. Therefore, there were 69% of the artistic type category respondents who were incorrectly classified into other categories. Based on the observation, 36% of the social type respondents were correctly predicted by the model so that there are as many as 64% of the social type categories who were incorrectly classified into other categories. The model correctly predicted 65.5% of the enterprising type respondents. Therefore, there were 34.4% of enterprising type categories which were classified into other categories. Finally, 17.4% conventional type respondents were correctly predicted by the model so that there were 82.6% conventional type respondents who were misclassified into other categories.

Table 6. Accuracy of model classification

Observed	Predicted						Correct
	R	I	A	S	E	C	
R	2	0	4	0	4	0	20.0%
I	0	22	6	0	6	2	61.1%
A	0	10	18	16	12	2	31.0%
S	0	6	10	18	14	2	36.0%
E	0	8	8	4	42	2	65.6%
C	0	0	10	10	18	8	17.4%
Overall	0.8 %	17.4 %	21.2 %	18.2 %	36.4 %	6.1 %	41.7 %

Although the overall parameters are significant at error level (α) 0.1, the classification accuracy is less than 50 %. This may be caused by the lack of representative predictor variables for modelling the Holland Personality Type or inappropriate selection of model.

4. Conclusion

Based on data analysis and discussion, it was concluded that the majority of respondents were classified into enterprising (24.2%) and artistic (22%) personality types. Most respondents (69.7%) were from science majors. The proportion of gender was approximately the same; 59.8% of the students were female and 40.2% were male. Most of the respondents' fathers were graduated with bachelor's degree (43.2%), while the mothers were majority bachelor's degree and senior high school graduates with the same percentage of 39.4%. Regarding the parents' income, 50% of respondents' parents had high monthly income of above IDR. 5 million. The high income was dominantly obtained from respondents whose fathers were entrepreneurs (39.4%) while the mothers were mostly housewives (43.9%).

Based on the individual multinomial logistics regression test, it could be observed that all predictor variables, namely, Major of studies (X_1), Gender (X_2), Father's Education (X_3), Mother's Education (X_4), Parent's Income (X_5), Father's Occupation (X_6) and Mother's Occupation (X_7) significantly influence the Holland Personality Type (Y) at the error level (α) 0.1.

Multinomial logistics regression model for Holland student personality type resulted in classification accuracy of only 41.7%. The low accuracy of classification may be due to a lack of predictor variables that were representative for modelling the students' Holland Personality Type or due to less appropriate selection of a model.

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