

## At what age does vocational tendency begin?

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### Abstract

The growth period takes place between the ages of 4-14 and the concept of occupation in children begins to form in this period. Vocational choice is affected by students' interests. This study aims to expand the age range of the short-sphere inventory by using supervised learning algorithms. In this research, the Short Sphere Inventory derived from Holland's theory is used as the material. The age range of the inventory includes 8th-grade, high school, and university students. In this research, a machine learning-based analytical model has been developed that allows the age range of the Short Sphere Inventory to be expanded. As a result, the measurements were confirmed with high predictive success and the age range was expanded. The main conclusion to be made by the results of this research is that the Short Sphere Inventory can be applied in 8th grades, 5th, 6<sup>th</sup> and 7th grade.

**Keywords:** Age; Hollands theory; machine learning; vocational personality.

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## 1. Introduction

Individuals want to work in a suitable environment where they can reflect their capacity, abilities, interests, values, and personal characteristics, and where they will be rewarded (Holland, 1996; Gundula et al., 2020; Ozcan & Uzunboylu, 2020; Hoff et al., 2022). The personality structures of people in the same profession are also similar, in other words, the choice of profession is an expression of personality (Basler & Kriesi, 2019; Wang, 2022). Therefore, the relationship between professional interests and personality is very important (Larson, Rottinghaus, & Borgen, 2002; McKay & Tokar, 2012), and professional interests play an important role in research on individual differences. If professional interests are an expression of personality, interest inventories can also be considered personality inventories (Zhang, Yuen & Chen, 2021; Baker, 2022; Mangion & Riebel, 2022). Individuals tend to choose university fields or professional environments that suit their personality orientations. The choice of academic field is affected by the interest patterns of the students, and in many studies, it has been revealed that the personality types suitable for the Holland (1997) typology, which is widely used in career counseling, are the predictors of the academic program they choose.

Holland's (1997) RIASEC model is the most basic interest model, it evaluated individual interests and abilities in six areas: realistic, investigative, artistic, social, enterprising, and conventional. His theory has had a wide impact on career counseling on both theoretical and practical grounds (Castelló & Cladellas, 2021). Each RIASEC dimension is characterized by specific personality-related attributes, for example, interests, values, and beliefs (Lerche, Burk, & Wiese, 2022). Often, only three dominant types of the six RIASEC types are used to identify a person (for example, the person is assigned a three-letter SAE code. Often, only three dominant types of the six RIASEC types are used to describe a person (for example, the person is assigned a three-letter SAE code. More specifically, the social type prefers to work with realistic type tools and machinery when dealing with social activities such as teaching and helping other people), or the investigative type likes to think and solve complex problems (Hartmann, Mouton, & Ertl, 2022).

Holland's RIASEC model is widely used in career information systems for three reasons; First of all, the model is easy to understand and explain. Second, there are many inexpensive and tested RIASEC-based assessment tools that can identify individuals' interests. Finally, the number of resources that can match RIASEC codes with occupations is high and it is easy to access them (McDaniel and Snell, 1999).

In Holland's theory, not only talents but also interests, that is, the most motivating subjects or areas for each person are taken into account (Ayriza, Triyanto, Setiawati, & Gunawan, 2020). A vocational interest inventory, the Short Sphere Inventory, was developed from Holland's theory. A short form consisting of 80 items, 40 of which are interests and 40 of which are perceived abilities, was created to facilitate the use of the inventory.

On the other hand, the development of professional interests can be observed as early as the age of three, when children begin to notice and imitate adults in their behavior (Howard and Walsh, 2010; Howard, Flanagan, Castine, & Walsh, 2015; Liu, McMahon, & Watson, 2015). It is increasingly recognized that students aged 8-10 years, as individuals think about their future careers starting from early adolescence (Auger, Blackhurst, & Wahl, 2005), and that this has a strong influence on their preparation for the career they choose (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Auger & Blackhurst, 2005). In addition, their preferences are usually not random but related to their temperamental style. Therefore, it is appropriate to use information about children's temperament to help them discover possible professional interests from the third grade. An earlier study by Holland (1985) on primary school children in the sixth grade found that self-concept was positively associated with career development. Considering career development as a lifelong process, early childhood studies can provide children with critical

opportunities to create meaningful life designs. However, if a person is not sufficiently conscious of career interests in childhood, they may face many problems in their future career choices (Ayryza et al., 2020).

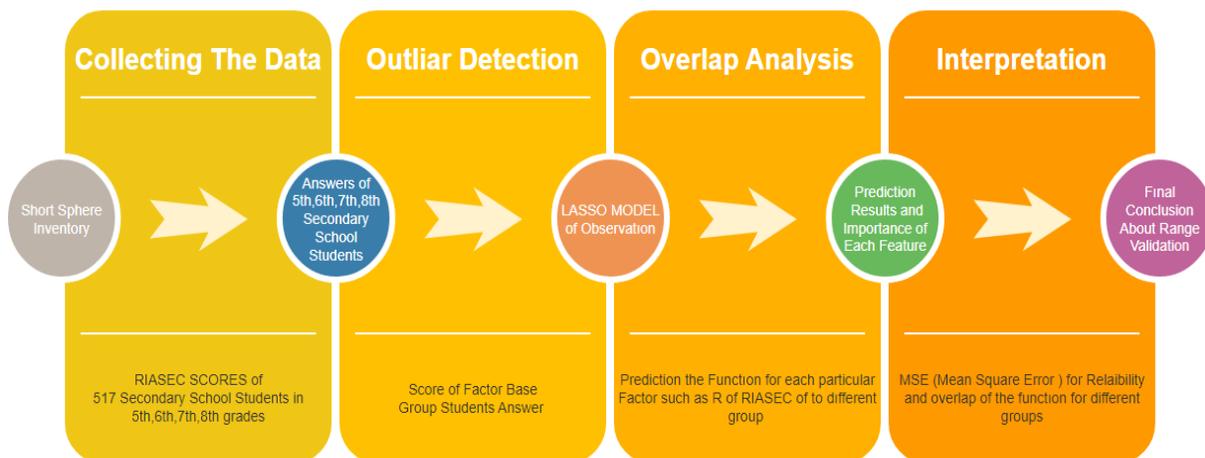
### 1.1. Purpose of study

As a result, considering the importance of career development at an early age, it is obvious that there is a need for an interest inventory for secondary school students. The determination of early professional tendency provides more effective training for the qualified workforce in this field. In the literature, there are studies on expanding the age range of the interest inventory (Koç, 2006) or similarly the psychological disorders inventory (Bilge, 2018). This study aims to expand the age range of the short-sphere inventory, which can be applied starting from the 8th grade, by using supervised learning algorithms until the 5th grade. An important issue to be considered at this point is the outliers in the sample.

## 2. Materials and Methods

This research was carried out with the participation of 522 students studying in 5, 6, 7, and 8 classes in Balıkesir and Bursa provinces in Turkey. Its researchers have devised a processing path shown in Figure 1.

**Figure 1**  
*Process Path*



### 2.1. Data collection instrument

The Personal Globe Inventory was used to measure the professional personality tendencies of the students. The Personal Globe Inventory (PGI) is a vocational interest inventory developed. This inventory is a scale that can be integrated into Holland's RIASEC model, measuring 12 factors in 2 segments, with 40 questions for each segment, and scoring each question from 1 to 5. Within the scope of the research, 522 students were asked to score 40 items from 1 to 5 in the "I like it" and "I can do it" segments.

#### 2.1.1. Outlier Detection

There are many algorithms for outlier detection. Outliers are located away from other data points in the scatterplot. Therefore, one of the Outlier detection calculation methods is to calculate the distance of the object to the center of the distribution. The minimum covariance determinant (MCD) method we used in our research is a very strong estimator of multivariate location and scattering. In the second step of the study, this consistency was evaluated by the group variance values of the scores given to the questions with the MCD algorithm. Observations that deviate significantly from other members of the sample in which they occur are called outliers (Grubbs, 1969). In other words, they are patterns in data that do not conform to a well-defined concept of normal behavior. In our sample, cases, where students answered

the questions randomly and inconsistently, were determined and these students were excluded from the sample, that is, outlier detection was made. Outlier detection has been used for centuries to detect and, where appropriate, remove outliers from data (Hodge & Austin, 2004). As a result, while doing this, very important information helps to make better decisions about

The data was obtained by identifying outliers, and the quality of the sample and the reliability of the research were increased as inconsistent and random answers were eliminated. Students who showed deviant behavior were excluded from the study. In Figure 2 shown below, questions about the scale factors and the relation between the Holland Personality Inventory - Personal globe Inventory are explained.

**Figure 2**  
*Short Sphire Inventory Factor-Question Diagram by RIASEC*

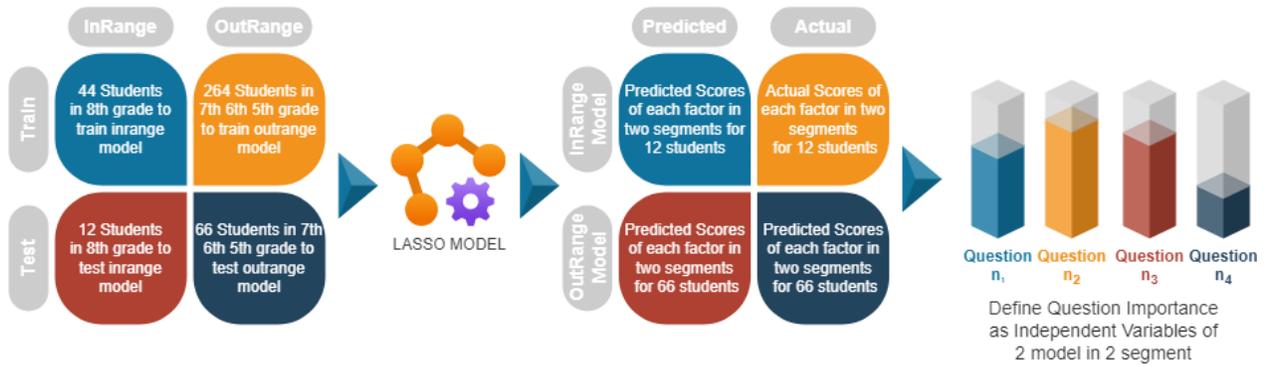


### 2.3 Analysis

The answers of students who gave honest answers in the 3rd step of the research were divided into two groups 8th grades in the range and 5,6 and 7th grades out of the range. By using the answers given by the students in the separated clusters to the questions, the factor scores of each observation were tried to be estimated by supervised machine learning algorithms. For this process, LASSO (least absolute shrinkage and selection operator) regression method was preferred. The reason for this is that the LASSO algorithm determines the effect coefficients of the independent variables used when analyzing a factor score, and the function of the scale can be obtained only from the answers. The two groups were separated and the datasets of each group were used to train 80% of the model and 20% to predict with the trained model. The estimation of 20% was compared with the actual values and the performance of the model was measured with the Mean Square Error (MSE) approach. MSE is a risk function corresponding to the expected value of the squared error loss, in other words, it is the mean squared difference between the estimated values and the true value (Bickel & Doksum, 2015).

The information on the model created for Overlap analysis is detailed in Figure 3 shown below.

**Figure 3**  
*Overlap Analyses Flow*



### 2.4. Interpretation

In a model with a low error value analyzed with the LASSO algorithm, the correlation of the question-to-question importance levels of each factor (independent variable) analyzed by the algorithm with the question grades suggested by the test, however, the estimation success of the in-range group and out-of-range group model were examined. The predictive success revealed by the In-Range model and the non-Ranj model for each factor was accepted as the reliability of the method, the overlapping of the question importance levels between the segments of the two models with the question importance levels suggested by the test, and the validity of its extension to the 5th, 6th and 7th grades

### 2.5. Ethics

This study did not breach any ethical laws regarding consent to participate, identity reveal or posing harm to the participants or other people in the environment.

## 3. Results

### 3.1 Criterion: Outlier Detection for Students' Honesty

For this criterion, the variance value between the answers to the questions that are grouped according to the relevant factors given by each participant was determined. These variance values were calculated with the detMCD package using the R program and the maximum cut-off point of the variance in the answers of a participant for the relevant actor was determined. It was thought that the students who had a variance value above this cut-off point showed an outlier attitude. Analytical metrics are given below in Table 1.

**Table 1**

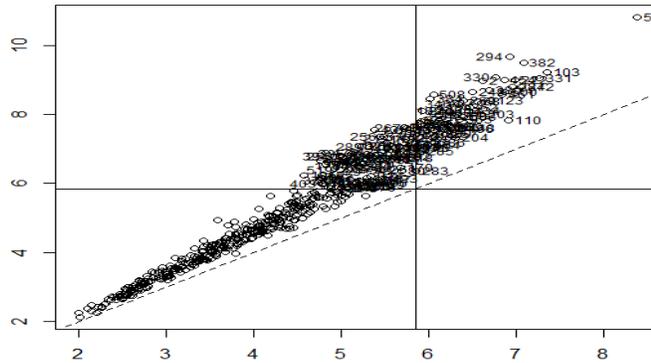
*Analytical Metrics of Minimum Covariance Determinant Algorithm*

Outier analyses metrics	Metric Name	Value
	Cut Off	5.84
	Sample	Deterministic
	Alpha	0.5
	Observation Quantity	522
	Outlier Observation Quantity	136
	Valid Observation Quantity	386

According to the cut-off point given by the MCD algorithm, it was understood that 136 of the students answered the questions inconsistently and randomly. The findings of each analysis made in the group of 386 people obtained by eliminating these observations are given below in Figure 03

**Figure 2**

*Distance – Distance Diagram for MCD Analyses*



### 3.2 Criterion: Overlap Analyses and Results to Interpret

For this criterion, the outputs of the created LASSO models were compared. The outputs of the models, model, segment, model performance, the importance levels of the questions, and the overlap ratios of these levels are shown in table 2 for the 8<sup>th</sup>-grade students and in table 3 for a lower grade than the 8<sup>th</sup>-grade students below.

**Table 2**

*8<sup>th</sup> Grade Students LASSO Model Results*

8 <sup>th</sup> Grade Students' Model Results	Factor Name	Mean Square Error	Important Question by Model	Actual Question By Test
I Like	Social Facilitating	0.1041667	1,11,21,31	1,11,21,31
	Managing	0.04166667	2,12,22,32	2,12,22,32
	Business Details	0.109375	3,13,23,33	3,13,23,33
	Data Processing	0.04166667	4,14,24,34,	4,14,24,34,
	Mechanical	0.15625	5,15,25,35	5,15,25,35
	Nature/Outdoors	0.09895833	6,16,26,35	6,16,26,35
	Artistic	0.08854167	7,17,27,37	7,17,27,37
	Helping	0.06770833	8,18,28,38	8,18,28,38
	Higher Prestige	0.09895833	9,19,29,39	9,19,29,39
	Lower Prestige	0.08333333	10,20,30,40	10,20,30,40
I Can	Social Facilitating	0.1066667	1,11,21,31	1,11,21,31
	Managing	0.09895833	2,12,22,32	2,12,22,32
	Business Details	0.06770833	3,13,23,33	3,13,23,33
	Data Processing	0.09	4,14,24,34,	4,14,24,34,
	Mechanical	0.1197917	5,15,25,35	5,15,25,35
	Nature/Outdoors	0.09375	6,16,26,35	6,16,26,35
	Artistic	0.125	7,17,27,37	7,17,27,37
	Helping	0.06	8,18,28,38	8,18,28,38
	Higher Prestige	0.1041667	9,19,29,39	9,19,29,39
	Lower Prestige	0.109375	10,20,30,40	10,20,30,40

**Table 3**

*Lower Grade Students Than 8<sup>th</sup> Grade Students LASSO Model Results*

7 <sup>th</sup> ,6 <sup>th</sup> , and 5 <sup>th</sup> Grade Students' Model Results	Factor Name	Mean Square Error	Important Question by Model	Actual Question By Test
I Like	Social Facilitating	0.1070076	1,11,21,31	1,11,21,31
	Managing	0.09280303	2,12,22,32	2,12,22,32
	Business Details	0.08712121	3,13,23,33	3,13,23,33
	Data Processing	0.1051136	4,14,24,34,	4,14,24,34,
	Mechanical	0.08333333	5,15,25,35	5,15,25,35
	Nature/Outdoors	0.1041667	6,16,26,35	6,16,26,35
	Artistic	0.06155303	7,17,27,37	7,17,27,37
	Helping	0.1013258	8,18,28,38	8,18,28,38
	Higher Prestige	0.07954545	9,19,29,39	9,19,29,39
	Lower Prestige	0.1079545	10,20,30,40	10,20,30,40
I Can	Social Facilitating	0.06969697	1,11,21,31	1,11,21,31
	Managing	0.08522727	2,12,22,32	2,12,22,32
	Business Details	0.1145833	3,13,23,33	3,13,23,33
	Data Processing	0.07454545	4,14,24,34,	4,14,24,34,
	Mechanical	0.08712121	5,15,25,35	5,15,25,35
	Nature/Outdoors	0.1060606	6,16,26,35	6,16,26,35
	Artistic	0.09564394	7,17,27,37	7,17,27,37
	Helping	0.07151515	8,18,28,38	8,18,28,38
	Higher Prestige	0.1193182	9,19,29,39	9,19,29,39
	Lower Prestige	0.08996212	10,20,30,40	10,20,30,40

According to the tables, Mean Square Error (MSE) represents the total model error for predicting each observation's factor results. The "Important Question by Model" column represents the suggested question numbers by the model to calculate the factor score and the "Actual Questions by Test" column represents the original question number that the inventory tells. In the results, it can be observed Question numbers that the model offers and the actual question numbers that the inventory tells are overlapped for both two models with represented MSE.

#### 4. Discussion

It is thought that our study has contributed more than one to the field. The first of these is to determine that it is appropriate to expand the age range of the occupational interest inventory up to the 5th grade. Considering that the early childhood period is a very important stage for children to start learning about their career interests (Dhillon & Kaur, 2005; Brown-Huston & Wilkerson, 2014), it is important to determine that the vocational interest inventory can be applied from the 5th grade. Thus, it can be ensured that children can make appropriate career planning that will add more value to their future with career awareness at an early age.

Another contribution of the research is that it shows that machine learning methods can be used in the studies of expanding the age range of the scales. Range expansion studies can be carried out in the areas needed with similar methods. The third contribution of the research is that the determination of inconsistent answers, which many researchers try to detect manually, is carried out by using machine learning and the outlier detection method.

#### 5. Conclusion

As a result, it has been shown that the perception of a profession can be observed at the 5th-grade level, a sample outside the age range for a scale can be included in the range with machine learning

methods, and misleading behaviors in the sample can be removed with machine learning methods. It is thought that the continuation of this study can make a great contribution to the field, at what age level and at what level the perception of a profession can be observed even below the 5th grade.

What kind of opportunities the similarity in vocational perceptions of secondary school students can create in social and educational activities can also be examined as a separate study subject in the continuation of this research. In this context, as a future work, the professional tendencies of the students can be examined in depth with a social network analysis.

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