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Examining Undergraduate Students' Inquiry Skills and Determining Predictors[1]

Engin Demir, Bandırma Onyedi Eylül University, edemirakademik@gmail.com,
0000-0002-6280-5467

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Abstract

Developing students' research skills not only increases their academic success but also equips them with essential abilities to interact with society and meet challenges in life. This study aims to investigate the inquiry skills of undergraduate students and identify the factors influencing these skills. Employing a relational research design, a quantitative approach was employed, with a sample of 554 undergraduate students. Data were gathered through the administration of the "Inquiry Skills Scale." Statistical analyses, including independent t-tests, one-way analysis of variance, and stepwise multiple regression, were conducted. Results revealed that participating students demonstrated a high level of inquiry skills. Moreover, those who perceived themselves as academically successful exhibited higher inquiry skills compared to their less successful counterparts. Students not considering post-graduate education showed lower inquiry skills than those aiming for it or undecided students. The primary predictors of students' inquiry skills were identified as their perception of academic success, followed by their perception of partial success, and their level of willingness in their chosen departments. Based on these findings, it is recommended that targeted interventions be implemented, both within the classroom and through extracurricular activities, to support students with lower levels of questioning skills.

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Introduction

Inquiry skills are essential for students for various important reasons, namely for their intellectual and personal development, academic success, and ability to engage with and contribute to the broader society. Moreover, developing students' inquiry skills in education enhances their critical thinking and problem-solving skills and guides their decision-making processes. Students may be unable to find a definitive answer to the problems they often encounter. Open-ended problems may have their own unique solutions (such as developing an artificial intelligence algorithm). This makes the concept of inquiry more important for students. Miftakhurrohmah et al. (2023) demonstrated that students who utilize inquiry skills can more easily conduct scientific research and solve the problems they encounter using scientific methods. As Wenning claimed (2007), scientific inquiry requires a high level of imagination and creativity. Universities should not be institutions where information is simply transmitted and students are passive listeners, but rather institutions where inquiry and creativity are fostered, and life-long learning skills are instilled (Polat & Odabaş, 2008). This is because when one considers the astonishing pace of development in science and technology, it does not seem possible for students to keep up with the speed solely by learning specific course content. In other words, it is difficult to keep up with this rapid change with a subject-based teaching approach. Hence, it is crucial for students to prioritize lifelong learning and develop higher-order thinking skills referred to as 21st-century skills (scientific inquiry, problem-solving, critical thinking, and creativity) to solve real-life problems they will encounter in the future. Scientific inquiry skills are transferable to various domains of knowledge. They empower students to approach any subject with a mindset of curiosity, critical analysis, and a commitment to seeking evidence-based answers. In this context, the rapidly advancing information age and associated societal changes necessitate cultivating individuals who can question and think critically. Given this, the present study argues the importance of examining the extent to which university students possess inquiry skills in scientific research . The current study aimed to examine the inquiry skills of university students and identify their predictors.

Several studies have found that inquiry-based teaching leads to better development of scientific inquiry skills, such as formulating hypotheses, designing experiments, collecting and analyzing data, and drawing conclusions (Farooq, 2023; Kutlu et al., 2022; Kruit et al., 2018). Inquiry-based approaches encourage students to actively engage in the learning process, which helps them acquire essential process skills (Verawati et al., 2022; Aslan, 2017). At the end of the inquiry process, it is aimed for students to question new situations they encounter by using their prior knowledge and to utilize the information and skills they acquire through inquiry in subsequent learning experiences (National Research Council, 2000). Definitions related to the concept of inquiry emphasize asking questions for a specific purpose and conducting research through questions to advance thinking and learning (Güneş, 2016). Inquiry in education relies on children assuming an active role in changing their understandings by following questions or addressing issues that draw their attention (Harlen, 2014). Palmer (2009) defines inquiry skills as proposing researchable questions, observing, explaining, and reporting. Skills such as accessing accurate information, interpreting, analyzing, questioning, and making inferences are becoming sought-after characteristics in individuals of all ages (Öz, 2020). Thus, having inquiry skills is one of the steps of lifelong learning. Inquiry is a high-level strategy that develops students' reasoning skills (Hunter & Arthur, 2016). That is to say, inquiry is associated

with the higher-order cognitive domain (Bloom, 1956), such as analysis, synthesis, and evaluation, rather than the basic understanding of fundamental knowledge at lower levels. Several studies have found that higher-order thinking skills, as defined by the upper levels of Bloom's Taxonomy, are crucial for developing critical thinking, problem-solving, and other necessary 21st-century competencies (Crowe et al., 2008; Voinohovska, 2024). These skills enable students to go beyond mere memorization and engage in deeper, more meaningful learning (Adams, 2015; Baransi & Burbara, 2019). Therefore, when monitoring students' thinking processes, it is important to assess their capacity to ask questions and inquire. While the extent to which teaching thinking is possible is debated, one of the best ways to develop thinking (De Bono, 2008) is to be curious and ask questions (Boghossian, 2012). In summary, inquiry skills are not only useful for academic success but are also essential for personal development, informed citizenship, and meaningful contributions to society in the context of lifelong learning.

The literature shows that research on the concept of inquiry has concentrated on teachers and science courses. In similar studies measuring inquiry skills, Okumuş (2020) examined the inquiry skills of middle school students and found that inquiry skills were higher in lower grades. The researcher associated this result with the transition of activities in lower grades to knowledge and exams in upper grades. In studies conducted with teacher candidates regarding inquiry skills (Acar Şeşen, et al., 2020; Alkış Küçükaydın, 2020; Aldan Karademir & Saracaloğlu, 2017; Balbağ & Aynur, 2020; Sarıkaya & Şakiroğlu, 2021), it was revealed that the inquiry skills of teacher candidates inquiry skills were above average. Yang and Heh (2007) compared the effects of laboratory use in applied courses on high school students' inquiry skills and found that students who used laboratories achieved significantly higher scores than their peers.

The following three research questions were formulated to guide the present research study:

RQ1: What is the level of university students' inquiry skills?

RQ2: Do university students' inquiry skills show a significant difference based on their;

1) Gender,

2) Desire to pursue graduate education,

3) Perceived academic achievement,

4) Level of willingness to enroll in their department?

RQ3: To what extent do gender, desire to pursue graduate education, perceived academic achievement and willingness to be enrolled in their department predict university students' inquiry skills?

Method

Study Design

Aiming to measure the inquiry skills of university students according to various variables and to determine their predictors, the study employed the correlational research design. In correlational research, the relationship between two or more variables is investigated without any intervention and manipulation of the variables (Fraenkel & Wallen, 2009).

Population and Sample

The sample size was determined as 372 using Raosoft sample size calculator (http://www.raosoft.com/samplesize.html?nosurvey) with a confidence level of 95% and a confidence interval of 5%. The data in the study were collected through convenience sampling, one of the non-probability sampling methods. In convenience sampling, the researcher forms the sample from the most accessible respondents (Cohen, Manion and Morrison, 2018). As a result, 554 volunteer university students from engineering faculty were reached.

The variables in the study were students' gender, desire to pursue graduate education, perceived academic achievement, and their level of willingness to be enrolled in their department. Numerical information regarding the demographic characteristics of the students participating in the study is presented in Table 1 below.

Table 1

Some Demographic Characteristics of the Participants

Variables	*Groups*	*Frequency*	*%*
Gender	Female	162	29.2
	Male	392	70.8
Desire to pursue graduate education	Yes	226	40.8
	No	90	16.2
	Undecided	128	31.4
Perceived academic achievement	Unsuccessful	60	10.8
	Partially successful	167	30.1
	Successful	327	59.0
Level of willingness to be enrolled in their department	Unwilling	62	11.2
	Partially willing	81	14.6
	Willing	411	74.2

As seen in Table 1, the students in the study group do not exhibit a balanced distribution among the groups. In terms of gender, 70.8% of the students were male. While 40.8% of the students wanted to pursue graduate education, 31.4% did not plan to pursue graduate education. While 59% of the students considered themselves academically successful, 10.8% considered themselves unsuccessful, and 30.1% partially successful. Finally, 74% of the students stated that they selected their department willingly.

Data Collection Tool

The data for the study were collected using the 'Inquiry Skills Scale' developed by Aldan Karademir and Saracaloğlu (2013). An Exploratory Factor Analysis (EFA) yielded a three-factor structure consisting of 14 items, and each factor was named. "Information Acquisition", "Information Control", and "Self-Confidence", respectively, according to the theoretical framework. Confirmatory Factor Analysis (CFA) results indicated that the model fit was acceptable, $\chi 2 = 336.86$, $\chi 2 /df = 4.55$, RMSEA= 0.06, GFI= 0.954, AGFI= 0.935, CFI= 0.928, and

NNFI= 0.911. Cronbach's alpha (α) values were calculated for each factor in the scale and the whole scale. The Cronbach's alpha (α) reliability coefficients were .76 for Information Acquisition, .66 for Information Control, and .82 for Self-Confidence, and .82 for the whole scale. Thus, the scale's validity and reliability were established, with the lowest score being 14 and the highest being 70. In the current study, Cronbach's alpha(α) reliability values were calculated for the entire scale and its factors. The Cronbach's alpha (α) coefficient for the overall scale was found to be .80, whereas it was .63 for Information Acquisition, .63 for Information Control, and .85 for Self-Confidence. According to DeVellis (2012), Cronbach's Alpha (α) coefficient is expected to be above .70. Lower Cronbach alpha values can be obtained in scales with fewer than 10 items. In such cases, an average inter-item correlation ranging from .2 to .4 is recommended (Briggs & Cheek, 1986, as cited in Pallant, 2016). In the present study, the mean inter-item correlation was found to be .234 for Information Acquisition and .331 for Information Control.

Data Analysis

Prior to the main analysis of the data from the Inquiry Skills Scale, the Kolmogorov-Smirnov test was run to test the assumption of normality, and skewness and kurtosis coefficients were examined to understand whether the variables showed a normal distribution. The values from the calculations are presented in Table 2 below.

Table 2

Values Regarding the Inquiry Skills Scale and its Factors

Scale Factors	*Kolmogorov-Smirnov*			*Skewness*	*Kurtosis*
	Statistic	*df*	*Sig.*		
Factor1: Information Acquisition	.097	536	.000	-.404	-.008
Factor 2: Information Control	.089	536	.000	-.168	-.248
Factor 3: Self-Confidence	.083	536	.000	-.153	-.564
Whole Scale: Inquiry Skills	.049	536	.003	-.143	-.249

As seen in Table 2, the results of the Kolmogorov-Smirnov test indicate that the scale does not exhibit a normal distribution ($p<.05$). However, the skewness and kurtosis values for the overall scale and all its factors range between -1 and +1. Skewness and kurtosis coefficients within the range of -1 to +1 can be considered as a measure of the normality assumption (Morgan, Leech, Gloeckner, & Barrett, 2004). Accordingly, it can be stated that the data were normally distributed.

When interpreting the mean values of the Inquiry Skills Scale, its sub-dimensions, and the overall scale, the minimum and maximum values obtained from the overall scale and its sub-dimensions are classified according to a five-point scale. This classification is presented in Table 3.

Table 3

Value Ranges for the Overall Scale and its Sub-Dimensions

Sub-dimension	*Never*	*Seldom*	*Sometimes*	*Often*	*Always*
Information Acquisition (6 items)	6.00-10.80	10.81-15.60	15.61-20.40	20.41-25.20	25.21-30.00
Information Control (5 items)	5.00-9.00	9.01-13.00	13.01-17.00	17.01-21.00	21.01-25.00
Self-Confidence (3 items)	3.00-5.40	5.41-7.80	7.81-10.20	10.21-12.60	12.61-15.00
Overall Scale	14.00-25.20	25.21-36.40	36.41-47.60	47.61-58.80	58.81-70.00

In the data analysis, independent samples t-tests were run to determine whether there were differences between the mean scores of the Inquiry Skills Scale and the mean scores of the scale sub-dimensions according to gender. One-Way Analysis of Variance (ANOVA) was utilized to ascertain whether the scores varied based on the participant students' desire to pursue graduate education, perceived academic achievement, and their level of willingness to be enrolled in the department. The analyses were interpreted by including the percentage, frequency, mean and standard deviation values of the variables at the .05 significance level. The Cohen's d statistic, calculated to assess the effect size of the standardized difference between the means, was reported. The ETA squared value obtained in the analysis was interpreted as .01=small effect, .06=medium effect, and .14=large effect (Cohen, 1988).

Stepwise regression, an appropriate statistical technique for prediction studies, was used. While the discrete variables in the study were included in the regression analysis by coding them as dummy variables, continuous variables were included in the analysis with their original values. Information on the dummy coding of all variables included in the analysis is provided in Table 4.

Table 4

Coding of Dummy Variables

Discrete Variables	*Level*	*Dummy Variable*	*Coding*	*Excluded Category*
Gender	1. Male 2. Female	Gender	Female: 0 Male: 1	Female
Desire to pursue graduate education	1. Yes 2. Undecided 3. No	Yes Undecided	Yes: 1 Undecided: 0 Yes: 0 Undecided:1	No
Perceived academic achievement	1. Unsuccessful 2. Partially successful 3. Successful	Unsuccessful Partially Successful	Successful: 1 Partially Successful: 0 Partially Successful: 0 Successful: 1	Unsuccessful
Level of willingness to be enrolled in their department	1. Unwilling 2. Partially willing 3. Willing	Unwilling Partially Willing	Willing: 1 Partially willing: 0 Willing: 0 Partially willing: 1	Unwilling

Since multiple regression analysis is highly sensitive to outliers (Pallant, 2016), 18 outlier data points were excluded from the analysis. Assumptions of multiple linear regression analysis

were tested, including normal distribution, linearity, constant variance, absence of autocorrelation and absence of multicollinearity among independent variables (Kalaycı, 2009). Relationships between standardized predicted values and standardized error values were examined with graphs to assess assumptions of normality and linearity (Figure 1 and Figure 2). According to Figure 1, the histogram and normal distribution curves generated for the standardized predicted values demonstrate a distribution close to normal, and according to Figure 2, it can be suggested that there is a linear and positive relationship between the variables.

Figure 1

Histogram and Normality Curve Regarding Inquiry Skills

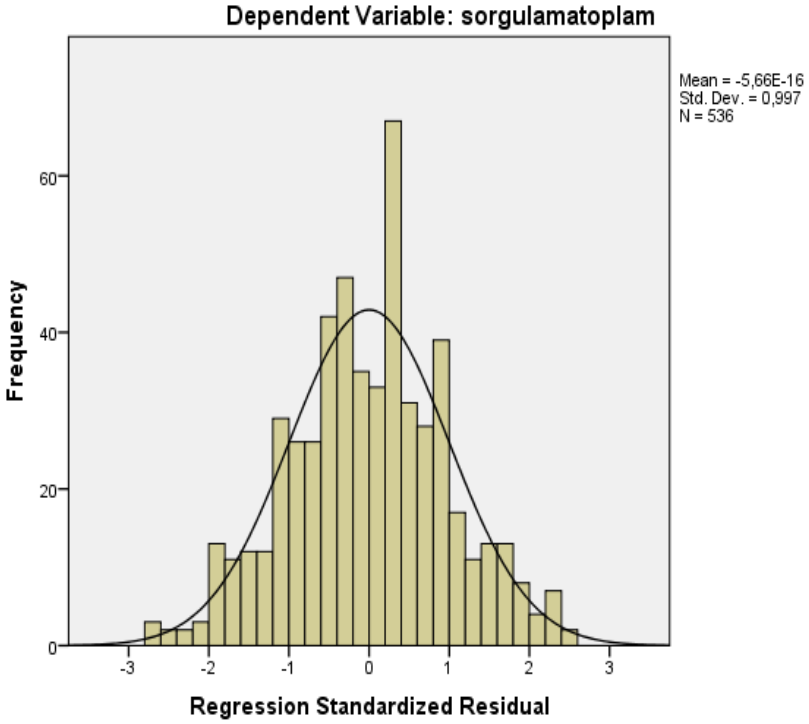
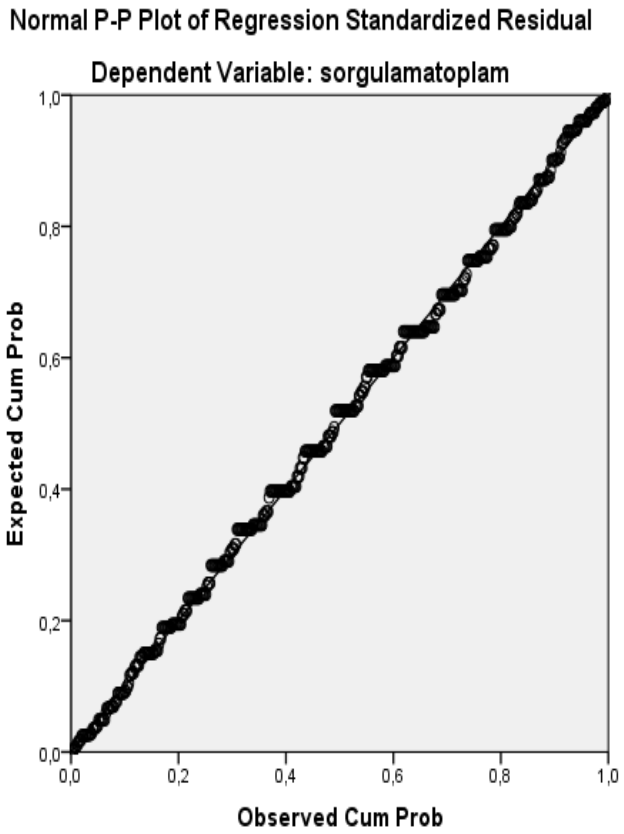


Figure 2

Linearity Distribution Regarding Inquiry Skills



The examination of the multicollinearity indicators among the predictor variables showed that the tolerance values ranged between 0.352 and 1.00, the Variance Inflation Factor (VIF) values ranged between 1.00 and 2.836, and the highest condition index (CI) value was 6.199. According to Pallant (2016), to avoid multicollinearity in the analysis, the VIF value should be less than 10, and the tolerance value should be greater than 0.10. In this case, it can be concluded that there is no multicollinearity problem. The Durbin-Watson statistic, used to test autocorrelation, indicates that values less than 1 and greater than 3 suggest errors among the residuals. A value close to 2- is preferred (Field, 2009, p. 236). In this study, a Durbin-Watson value of 1.80 indicated an absence of autocorrelation. The standardized residual value ranged between -2.73 and 2.53. Tabachnick and Fidell (2013) suggest that these values should fall between +3.3 and -3.3. The Mahalanobis distance values varied between .794 and 14.416. This value is below the threshold of 24.32, established for a minimum number of independent variables, which is seven (Pallant, 2016). The maximum value for Cook's Distance is 0.034. The fact that this value was below 1 indicated that the data were fit for regression (Tabachnick & Fidell, 2013).

Findings

In this section, the findings obtained in the present study are presented in line with the sub-problems.

Level of University Students' Inquiry Skills

The descriptive statistics for the inquiry skills scores of the scale sub-dimensions and the overall scale are presented in Table 5.

Table 5

Descriptive Statistics for Inquiry Skills

Scale Factors	*N*	*Min.*	*Max*	$\bar{x}$	*Sd*
Factor 1: Information Acquisition	536	15.00	30.00	24.15	2.90
Factor 2: Information Control	536	9.00	25.00	17.88	3.16
Factor 3: Self-Confidence	536	3.00	15.00	9.91	3.02
Whole Scale: Inquiry Skills	536	34.00	69.00	51.95	6.88

As seen in Table 5, students' mean scores for Information Acquisition, Information Control, and the overall scale were at the "often" level. The Self-Confidence scores were found to be at the "seldom" level.

Examination of Inquiry Skills according to Sex Variable

Independent samples t-tests were conducted to determine whether there was a significant difference in the inquiry skills for the gender variable. The results of the analysis are presented in Table 6.

Table 6

Results of T-test Analysis According to Gender

	Gender	*N*	$\bar{x}$	*Sd*	*df*	*t*	*p*
Factor 1: Information Acquisition	Female	160	24.53	3.02	534	1.936	.053
	Male	376	23.99	2.85			
Factor 2: Information Control	Female	160	17.89	3.30	534	.036	.971
	Male	376	17.88	3.11			
Factor 3: Self-Confidence	Female	160	10.03	3.15	534	.585	.559
	Male	376	9.86	2.97			
Whole Scale: Inquiry Skills	Female	160	52.45	7.57	534	1.090	.276
	Male	376	51.74	6.57			

As can be seen in Table 6, no significant difference is observed between university students' scores on the sub-dimensions of Information Acquisition ($t=1.936$, $p>.05$), Information Control ($t=.036$, $p>.05$), Self-Confidence ($t=.585$, $p>.05$), and the total scores of Inquiry Skills ($t=1.090$, $p>.05$) of university students based on gender.

Examination of Inquiry Skills According to the Students' Desire to Pursue Graduate Education Variable

The arithmetic means and standard deviations of the scores on the Inquiry Skills Scale according to the variable of the desire to pursue graduate education were calculated. These results are presented in Table 7.

Table 7

Frequency, Mean Score, and Standard Deviation Values According to Students' Desire to Pursue Graduate Education

Desire to pursue graduate education	*N*	*Information Acquisition*		*Information Control*		*Self-Confidence*		Inquiry Skills	
		x̄	*Sd*	*x̄*	*Sd*	*x̄*	Sd	x̄	Sd
1. Yes	220	24,34	2,79	18.30	3.04	9.94	3.11	52.60	6.80
2. No	84	23.52	3.09	16.95	3.46	9.19	2.96	49.66	7.07
3. Undecided	232	24.19	2.91	17.82	3.09	10.14	2.92	52.16	6.74

Table 7 demonstrates that the scores of Inquiry Skills vary according to students' desire to pursue graduate education. ANOVA was performed to determine whether the scores showed a significant difference, and the analysis results are presented in Table 8.

Table 8

ANOVA Test Results Based on Students' Desire to Pursue Graduate Education

		Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*	*Sig. Dif. (Scheffe)*	*Eta Squared*
AInformation Acquisition	Between Groups	41.878	2	20.93	2.487	.084	-	-
	Within Groups	4487.577	533	8.41				
	Total	4529.455	535					
CInformation Control	Between Groups	113.512	2	56.75	5.764	.003	2<1	.02
	Within Groups	5248.546	533	9.84				
	Total	5362.058	535					
Self-Confidence	Between Groups	56.737	2	28.36	3.132	.044	2<3	.01
	Within Groups	4827.315	533	9.057				
	Total	4884.052	535					
Inquiry Skills	Between Groups	541.923	2	270.96	5.824	.003	2<1 2<3	.02
	Within Groups	24795,911	533	46,52				
	Total	25337,834	535					

In Table 8, it is observed that there is a statistically significant difference in the scores of inquiry skills in the sub-dimensions of Information Control (F (2,535)=5.764, p<.05), Self-Confidence (F(2,535)=3.132, p<.05), and the overall scale (F(2,535)=5.824, p<.05) based on the desire to pursue graduate education. In contrast, the difference between the scores in the sub-dimension of Information Acquisition was not significant. Following this process, complementary post-hoc analysis techniques were conducted to determine which groups accounted for the significant differences identified after ANOVA.

To decide which post-hoc multiple comparison technique to use after ANOVA, the hypothesis of whether the variances of the group distributions were homogeneous or not was first tested using Levene's test. When the variances were found homogeneous, the Scheffe multiple comparison method was employed, whereas Games-Howell technique was utilized when the variances were found to be non-homogeneous. Accordingly, it was observed that the scores for inquiry skills, based on the desire to pursue graduate education, were lower for students who did not desire to pursue graduate education were lower than those who did. Similarly, the self-confidence skills and inquiry skills of students who did not want to pursue graduate education were lower than those of students who were undecided about pursuing graduate education. Also, the eta-squared values were small.

Examination of Inquiry Skills According to the Perceived Academic Achievement Variable

The arithmetic means and standard deviations of the Inquiry Skills Scale scores were calculated according to the variable of perceived academic achievement. The results are presented in Table 9.

Table 9

Frequency, mean score, and standard deviation values according to the academic perceived achievement variable

Perceived Academic achievement	*N*	*Information Acquisition*		*Information Control*		*Self-Confidence*		*Inquiry Skills*	
		$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*
1. Unsuccessful	53	21.51	3.32	15.75	3.34	8.58	3.20	45.85	7.34
2. Partially successful	163	24.06	2.76	17.48	3.22	9.59	3.05	51.13	6.50
3. Successful	320	24.64	2.67	18.45	2.92	10.30	2.90	53.38	6.37

As can be seen in Table 9, the inquiry skills scores vary according to students' perceived academic achievement. ANOVA was performed to determine whether the scores showed a significant difference based on perceived academic achievement. The results of the analysis are provided in Table 10.

Table 10

ANOVA test results according to the perceived academic achievement variable

		Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*	*Sig. Dif. (Scheffe)*	*Eta Squared*
AInformation Acquisition	Between Groups	446.873	2	223.437	29.171	.000	2>1 3>1	
	Within Groups	4082.582	533	7.660				.099
	Total	4529.455	535					
CInformation Control	Between Groups	368.475	2	184.237	19.665	.000	3>1 3>2 2>1	
	Within Groups	4993.583	533	9.369				.069
	Total	5362.058	535					
Self-Confidence	Between Groups	158.524	2	79.262	8.940	.000	3>1 3>2	
	Within Groups	4725.528	533	8.866				.032
	Total	4884.052	535					
Inquiry Skills	Between Groups	2741.025	2	1370.513	32.327	.000	3>1 3>2 2>1	
	Within Groups	22596,809	533	42.396				.108
	Total	25337,834	535					

As observed in Table 10, there is a statistical difference between the scores in the sub-dimensions of the Inquiry Skills Scale: Information Acquisition ($F(2,535)=29.171$, $p<.05$), Information Control ($F(2,535)=19.665$, $p<.05$), Self-Confidence ($F(2,535)=8.940$, $p<.05$), and the overall scale ($F(2,535)=32.320$, $p<.05$). After confirming that the variances of group distributions were homogeneous using the Levene's test, Scheffe's method of multiple comparison was used. Accordingly, students who perceived themselves as academically unsuccessful had lower Information Acquisition scores than those who perceived themselves as successful and partially successful. The eta squared value was .09, which indicates a moderate level. The scores of students who perceived themselves as academically successful in controlling information were higher than those who perceived themselves as academically unsuccessful and partially successful. Similarly, the scores of students who perceived themselves as partially successful were higher than those who perceived themselves as academically unsuccessful in controlling information. The eta squared value was .06, indicating a moderate level. In the Self-Confidence sub-dimension, the scores of students who perceived themselves as academically successful were higher than those who perceived themselves as academically unsuccessful and partially successful. The effect size was .03, indicating a small level. Finally, the scores of the inquiry skills for students who perceived themselves as academically successful were higher than those who perceived themselves as academically unsuccessful and partially successful. Similarly, the scores of the inquiry skills for the students who perceived themselves as partially successful were higher than those who perceived themselves as unsuccessful. The eta squared value was .108, indicating a moderate level.

Examination of Inquiry Skills According to the Variable of Willingness to be enrolled in their Department

The arithmetic means and standard deviations of the Inquiry Skills Scale scores were calculated according to the variable of willingness to be enrolled in their department. The results are presented in Table 11.

Table 11

Frequency, Mean Score, and Standard Deviation Values According to The Level of Willingness to be Enrolled in Their Department

Being Enrolled in their department	*N*	*Information Acquisition*		*Information Control*		*Self-Confidence*		*Inquiry Skills*	
		$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*	$\bar{x}$	*Sd*
1. Unwilling	56	23.46	3.60	16.61	3.64	9.27	3.71	49.34	8.29
2. Partially willing	78	23.33	3.03	17.01	2.88	9.14	2.65	49.49	6.79
3. Willing	402	24.41	2.74	18.23	3.08	10.15	2.95	52.80	6.49

As observed in Table 11, the inquiry skills scores vary according to the variable of willingness to be enrolled in their department. ANOVA was performed to determine whether the scores showed a significant difference according to the level of willingness to be enrolled in their department, and the analysis results are presented in Table 12.

Table 12

ANOVA Test Results According to the Level of Willingness to be Enrolled in Their Department

		Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*	*Sig. Dif. - Howell)*	*Eta Squared*
Information Acquisition	Between Groups	105.099	2	52.549	6.331	.002	3>2	.023
	Within Groups	4424.356	533	8.301				
	Total	4529.455	535					
Information Control	Between Groups	199.694	2	99.847	10.309	.000	3>1 3>2 2<1	.037
	Within Groups	5162.364	533	9.685				
	Total	5362.058	535					
Self-Confidence	Between Groups	93.184	2	46.592	5.183	.006	3>2	.019
	Within Groups	4790.869	533	8.988				
	Total	4884.052	535					
Inquiry Skills	Between Groups	1142.520	2	571.260	12.584	.000	3>2	.045
	Within Groups	24195.314	533	45.395				
	Total	25337.834	535					

In Table 12, it is observed that there is a significant difference between the scores in the sub-dimensions of the Inquiry Skills Scale: Information Acquisition ($F(2,535)=6.331$, $p<.05$),

Information Control (F(2,535)=10.339, p<.05), Self-Confidence (F(2,535)=5.183, p<.05), and the overall scale (F(2,535)=12.584, p<.05) according to the variable of willingness to be enrolled in their department. After it was determined that the variances of the group distributions were not homogeneous using Levene's test, the Games-Howell multiple comparison technique was utilized. Accordingly, it was found that students who chose the department willingly had higher scores in Information Acquisition compared to those who were enrolled in their department partially willingly. The eta squared value was .02, indicating a small level of effect. The Information Control scores of the students who were enrolled willingly in the department were higher than those who were enrolled in the department partially willingly and unwillingly. Partially willing students had lower scores than unwilling students. The eta squared value was .03, indicating a small effect size. Finally, regarding the Self-Confidence sub-dimension and overall inquiry skills, it was found that the scores of the students who were enrolled willingly in the department were higher than the scores of the students who were enrolled partially willingly in the department. The effect size was found to be small.

Examination of the Predictors of Inquiry Skills

The results of the multiple regression analysis performed using the stepwise model on the data regarding the variables of gender, desire to pursue graduate education, perceived academic achievement, and willingness to be enrolled in their department, which are all regarded as factors affecting the inquiry skills scores, are presented in Table 13. As presented in Table 13, the stepwise regression analysis excludes the variables regarding gender and graduate education in the analysis since they did not predict inquiry skills significantly.

Table 13

Results of Stepwise Multiple Regression Analysis Predicting Inquiry Skills

	Model-Predictor variables	*B*	*Std. Error*	*Beta*	*t*	*sig*	*Partial (r)*	*Part (R)*	*R*	R^2	*F*	*p*
Model 1	Constant	49.833	.453		109.910	.00			.253	.064	36,621	.000
	Successful	3.551	.587	.253	6.052	.00	.253	.253				
Model 2	Constant	45.849	.894		51.264	.00			.329	.108	32.327	.000
	Successful	7.535	.966	.538	7.804	.00	.320	.319				
	Partially Successful	5.280	1.030	.353	5.128	.00	.217	.210				
Model 3	Constant	46.314	.900		51.474	.00			.352	.124	25.116	.000
	Successful	7.371	.959	.526	7.683	.00	.316	.312				
	Partially Successful	5.253	1.021	.351	5.143	,00	.218	.209				
	Partially Willing	-2.465	.794	-.126	-3.106	.00	-.133	-.26				

As observed in Table 13, according to the regression analysis, three models were formed when the predictor variables were gradually added. While "successful" was the predictor variable in the first model, "partially successful" variable was added to the second model. In the third model, it was noticed that 12% (R^2= .214) of the variance in the predictor variable of being enrolled in their department partially willingly was explained by these three variables.

Upon examining the bivariate and partial correlations, it is noted that there is a positive correlation with low-level inquiry skills for both successful ????a positive correlation with a low-level inquiry skills for both successful (r=-.32) and partially successful (r=.22) perceptions. A low-level negative correlation (r=-.13) was observed between being enrolled in the department partially willing and inquiry skills.

The model created to explain the inquiry skills score was significant at α=.05 level (F=25.116 p<.05). According to the standardized regression coefficient in the third model, which explains the largest variance in the predictor variable, it was observed that the variable accounting for the largest variance in inquiry skills scores among the predictor variables was perceiving oneself to be academically successful (β=.52), followed by the variable perceiving oneself partially successful (β=.35) and being enrolled in the department partially willingly (β=-.12). According to the third model of the stepwise multiple regression analysis, the regression equation for the prediction of inquiry skills was as follows:

Inquiry Skills =46.314+7.371*Successful+5.253*Partially Successful-2.465*Partially Willing

Discussion and Recommendations

The present study aimed to examine the inquiry skills of university students according to the variables of gender, desire to pursue graduate education, perceived academic achievement, and being enrolled willingly in their department.

1. According to the study results, the inquiry skills of university students were at a high level across the scale. When the sub-factors were analyzed, the mean scores of the students for Information Acquisition, Information Control, and the overall scale were at the “often” level, whereas Self-Confidence scores were at the “sometimes” level. In similar studies on inquiry skills conducted with university students (Alkış Küçükaydın, 2020; Balbağ & Aynur, 2020), the researchers found that students' inquiry skills were above average.
   The examination of the scores of the scale sub-dimensions and the overall scale did not reveal a significant difference according to the gender variable. Similar studies conducted with preservice teachers (Bedir & Duman, 2017; Elmalı & Yıldız, 2017) concluded that the gender variable did not determine inquiry skills. That gender is not determinative of inquiry skills, which are intellectual skills, is a significant result.
2. When inquiry skills were analyzed according to the variable of students' perceived academic achievement, it was observed that students who considered themselves as partially successful and successful received higher average scores in all sub-dimensions of the scale and the overall scale compared to students who perceived themselves as unsuccessful, and they differed significantly. The literature has reported a significant positive relationship between university students' inquiry and self-directed learning skills (Öztürk et al., 2017). Varlı and Sağır (2019) and Balım (2009) concluded that inquiry-based learning increases student achievement. These results suggest that the high academic achievement of students with high-level inquiry skills may be related to students' learning skills in this study.
3. The study results showed that the inquiry skills of students who did not want to pursue graduate education were lower than those who wanted to pursue graduate education and undecided students. The participating students who did not want to pursue graduate

education were also students possessing a low level of perceived academic achievement. Therefore, this result can be interpreted as students with low academic achievement may also have low inquiry skills. This result is also consistent with the studies of Varlı and Sağır (2019) and Balım (2009), which argued that inquiry-based learning increases student achievement.

4. The students who were enrolled in their department willingly had higher scores in Information Acquisition, Information Control, Self-Confidence, and the overall scale compared to the students who were enrolled in their department partially willingly. In order for students to be successful and contribute to their fields, they must first have a predisposition to that field and be interested in their fields. When students are happy and enjoy working on academic subjects, their academic success increases. This explains the higher level of inquiry skills of students who major in the field they like or want.

Inquiry skills showed a moderate positive relationship with those who perceived themselves as academically successful and a low positive relationship with those who perceived themselves as partially successful. In the study, perceived academic achievement of being successful or partially successful was determined to be a predictor of inquiry skills. These results revealed again that students with a high level of perceived academic achievement also have high inquiry skills.

The study also revealed a low level and negative relationship between being enrolled in their department partially willingly and inquiry skills and that being enrolled in their department partially voluntarily is a predictor of inquiry skills. This result shows that the inquiry skills of the students enrolled in their department partially willingly were low.

Conclusion

In the present study, where we examined the inquiry skills of university students according to various variables, we obtained significant results. The scores of the participant students' inquiry skills were found to be at a high level. The scale used in the study, which was a self-assessment scale and is vital to note, revealed positive relationships between students' inquiry skills and the variables of perceived academic achievement, being enrolled in the department willingly, and their desire to pursue graduate education.

These students are likely to be those who are interested in their departments, possess predispositions, and thus have positive attitudes towards learning. The study results revealed the importance of students' selecting their majors based on their interests and, in this context, the importance of proper guidance, especially during K12. The interest of students currently continuing their education in the department may increase over time. Planned in-class and out-of-class (out of school) activities can be arranged within the department for this purpose. Thus, increasing students' interest and attitudes towards the department can also improve their inquiry skills. In addition, promoting inquiry-based teaching in university education also supports the development of inquiry skills. One effective way to strengthen higher education institutions is by helping students develop advanced skills that will prepare them to navigate the uncertainties they may face in the future. Finally, more in-depth research should be conducted on whether the increase in academic achievement directly affects inquiry skills. Researchers can explore the role of teacher knowledge, beliefs, and practices in facilitating the development of students' inquiry skills.

Declarations

Ethical Approval and Informed Consent

This study was approved by Bandırma Onyedi Eylül University Institutional Ethical Review Board. All procedures in this study were conducted in accordance with Bandırma Onyedi Eylül University Institutional Review Board's approved protocols. Written informed consent was obtained from the participants for their anonymized information to be published in this article.

Supplemental Material

There are no supplemental materials for this paper.

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TÜRKÇE GENİŞ ÖZET
Lisans Öğrencilerinin Sorgulama Becerilerinin İncelenmesi ve Yordayıcılarının Belirlenmesi

Giriş

Sorgulama becerileri; öğrencilerin entelektüel ve kişisel gelişimi, akademik başarısı ve topluma katkı sağlamaları açısından hayati öneme sahiptir. Bu beceriler; eleştirel düşünme, problem çözme ve karar verme süreçlerini geliştirir. Öğrenciler sıklıkla kesin cevapları olmayan açık uçlu sorunlarla karşılaşırlar, bu da sorgulamayı önemli kılar. Üniversiteler, bilgi aktaran ve öğrencilerin pasif dinleyiciler olduğu kurumlar yerine, sorgulama ve yaratıcılığı teşvik eden ve yaşam boyu öğrenme becerilerini aşılayan kurumlar olmalıdır (Polat & Odabaş, 2008). Bilim ve teknolojideki hızlı gelişmeler, geleneksel konu temelli öğretimle bu değişimlere ayak uydurmayı zorlaştırır. Bu nedenle, öğrencilerin yaşam boyu öğrenme ve üst düzey düşünme, sorgulama, problem çözme, eleştirel düşünme becerilerini ve yaratıcılıklarını geliştirmeleri gerekmektedir.

Sorgulama becerileri, çeşitli bilgi alanlarına aktarılabilir ve merak, eleştirel analiz ve kanıta dayalı cevapların arayışını teşvik eder. Sorgulama, belirli bir amaç için sorular sormayı, düşünmeyi, öğrenmeyi ilerletmek için araştırma yapmayı içerir (Güneş, 2016) ve dikkati çeken soruları aktif olarak takip etmeyi gerektirir (Harlen, 2014). Palmer (2009), sorgulama becerilerini araştırılabilir sorular önerme, gözlem yapma, açıklama ve raporlama olarak tanımlar. Sorgulama becerileri, yaşam boyu öğrenme için kritiktir ve öğrencilerin akıl yürütme yeteneklerini geliştirir (Hunter & Arthur, 2016); analiz, sentez ve değerlendirme gibi yüksek düzeyde bilişsel alanlarla uyumludur (Bloom, 1956). Öğrencilerin soru sorma ve sorgulama kapasitelerini değerlendirmek önemlidir. Merak ve soru sormak, düşünmeyi geliştirmenin anahtarıdır (De Bono, 2008; Boghossian, 2012). Özetle, sorgulama becerileri sadece akademik başarı için değil, aynı zamanda kişisel gelişim, bilinçli vatandaşlık ve topluma anlamlı katkılar sağlama açısından da hayati öneme sahiptir. Bu araştırma çalışmasını yönlendirmek için şu üç araştırma sorusu formüle edilmiştir:

1. Üniversite öğrencilerinin sorgulama beceri düzeyi nedir?
2. Üniversite öğrencilerinin sorgulama becerileri;
    a) Cinsiyete,
    b) Lisansüstü eğitim alma isteğine,
    c) Algılanan akademik başarıya,
    d) Bölümü isteyerek seçme düzeylerine göre, anlamlı bir farklılık gösteriyor mu?
3. Cinsiyet, lisansüstü eğitim alma isteği, algılanan akademik başarı ve bölümü isteyerek seçme, üniversite öğrencilerinin sorgulama becerilerini ne derecede yordamaktadır?

Yöntem

Üniversite öğrencilerinin sorgulama becerilerini çeşitli değişkenlere göre ölçmeyi ve bu becerilerin yordayıcılarını tespit etmeyi amaçlayan bu çalışma, ilişkisel araştırma tasarımı kullanılarak gerçekleştirilmiştir. Örneklem büyüklüğü, %95 güven düzeyi ve %5 güven aralığı ile Raosoft örneklem büyüklüğü hesaplayıcısı (http://www.raosoft.com/samplesize.html?nosurvey) kullanılarak 372 olarak belirlenmiştir. Veriler Türkiye'deki üç farklı devlet üniversitesinden toplanmıştır. Çalışmadaki veriler, olasılıksız örnekleme yöntemlerinden biri olan kolayda örnekleme yoluyla toplanmıştır. Kolayda örneklemede, araştırmacı en erişilebilir katılımcılardan başlayarak örneklemi oluşturur (Cohen, Manion ve Morrison, 2018). Sonuç olarak, 554 gönüllü mühendislik fakültesi öğrencisine ulaşılmıştır.

Çalışmanın verileri, Aldan Karademir ve Saracaloğlu (2013) tarafından geliştirilen 'Sorgulama Becerileri Ölçeği' kullanılarak toplanmıştır. Açıklayıcı faktör analizi (AFA), 14 maddeden oluşan üç faktörlü bir yapı ortaya koymuş ve her bir faktör teorik çerçeveye göre sırasıyla "bilgi edinme", "bilgiyi kontrol etme" ve "özgüven" olarak adlandırılmıştır. Analize geçmeden önce, Sorgulama Becerileri Ölçeği'nden elde edilen verilerin normallik varsayımını test etmek için Kolmogorov-Smirnov testi uygulanmış, değişkenlerin normal dağılım gösterip göstermediğini anlamak için çarpıklık ve basıklık katsayıları incelenmiş ve verilerin normal dağılım gösterdiği sonucuna varılmıştır.

Bulgular

Yapılan analizler sonucunda öğrencilerin "bilgi edinme", "bilgiyi kontrol etme" ve genel ölçek için sorgulama becerileri ortalama puanları "sıklıkla" düzeyinde, "özgüven" puanları ise "nadiren" düzeyinde bulunmuştur. Cinsiyetin öğrencilerin sorgulama becerileri üzerinde anlamlı bir farklılık yaratmadığı görülmüştür. Sorgulama becerileri puanlarının, öğrencilerin lisansüstü eğitim alma isteğine göre değişip değişmediğini belirlemek için ANOVA testi yapılmıştır. Buna göre, lisansüstü eğitim alma isteğine göre sorgulama becerileri puanlarının, lisansüstü eğitim almak istemeyen öğrenciler için, lisansüstü eğitim almak isteyen öğrencilere göre daha düşük olduğu gözlemlenmiştir. Sorgulama becerileri puanlarının öğrencilerin algılanan akademik başarılarına göre değişip değişmediğini belirlemek için ANOVA testi yapılmıştır. Buna göre kendilerini kısmen başarılı ve başarılı olarak değerlendiren öğrencilerin, kendilerini başarısız olarak değerlendiren öğrencilere göre ölçeğin tüm alt boyutlarında ve genel ölçek ortalama puanlarında daha yüksek puanlar aldıkları ve anlamlı bir şekilde farklılaştıkları gözlemlenmiştir. Çalışma ayrıca, bölümlerini kısmen isteyerek seçme ile sorgulama becerileri arasında düşük düzeyde ve negatif bir ilişki olduğunu ve bölümlerini kısmen isteyerek seçmenin sorgulama becerilerinin bir yordayıcısı olduğunu ortaya koymuştur.

Tartışma

Çalışma sonuçlarına göre, üniversite öğrencilerinin sorgulama becerileri genel olarak yüksek düzeydedir. Üniversite öğrencileriyle yapılan benzer sorgulama becerileri çalışmalarında (Alkış Küçükaydın, 2020; Balbağ & Aynur, 2020), araştırmacılar öğrencilerin sorgulama becerilerinin ortalamanın üzerinde olduğunu bulmuşlardır.

Öğrencilerin algılanan akademik başarı değişkenine göre sorgulama becerileri incelendiğinde, kendilerini kısmen başarılı ve başarılı olarak değerlendiren öğrencilerin, kendilerini başarısız olarak değerlendiren öğrencilere göre ölçeğin tüm alt boyutlarında ve genel ölçek ortalama puanlarında daha yüksek puanlar aldıkları ve anlamlı bir şekilde

farklılaştıkları gözlemlenmiştir. Literatürde, üniversite öğrencilerinin sorgulama becerileri ile kendi kendine öğrenme becerileri arasında anlamlı pozitif bir ilişki olduğu bildirilmiştir (Öztürk ve ark., 2017). Varlı ve Sağır (2019) ve Balım (2009), sorgulamaya dayalı öğrenmenin öğrenci başarısını artırdığını belirtmişlerdir. Bu sonuçlar, yüksek sorgulama becerilerine sahip öğrencilerin yüksek akademik başarıları algılarının, öğrencilerin öğrenme becerileri ile ilişkili olabileceğini düşündürmektedir.

Çalışma sonuçları, lisansüstü eğitim almak istemeyen öğrencilerin sorgulama becerilerinin, lisansüstü eğitim almak isteyen ve kararsız olan öğrencilere göre daha düşük olduğunu göstermiştir. Lisansüstü eğitim almak istemeyen katılımcı öğrenciler, aynı zamanda algılanan akademik başarı düzeyi düşük olan öğrencilerdir. Bu nedenle, bu sonuç, düşük akademik başarıya sahip öğrencilerin aynı zamanda düşük sorgulama becerilerine sahip olabileceği şeklinde yorumlanabilir. Bu sonuç, sorgulamaya dayalı öğrenmenin öğrenci başarısını artırdığını savunan Varlı ve Sağır (2019) ve Balım (2009) çalışmalarının sonuçlarıyla da tutarlıdır.

Sorgulama becerileri, kendilerini akademik olarak başarılı algılayanlar ile orta düzeyde, kısmen başarılı algılayanlar ile düşük düzeyde pozitif ilişki göstermiştir. Çalışmada, algılanan akademik başarı algısı, başarılı veya kısmen başarılı olma değişkenlerinin, sorgulama becerilerinin bir yordayıcısı olduğu belirlenmiştir. Bu sonuçlar, yüksek akademik başarı algısına sahip öğrencilerin aynı zamanda yüksek sorgulama becerilerine sahip olduğunu yeniden ortaya koymuştur. Çalışma ayrıca, bölümlerine kısmen isteyerek seçme ile sorgulama becerileri arasında düşük düzeyde ve negatif bir ilişki olduğunu ve bölümlerini kısmen isteyerek seçmenin sorgulama becerilerinin bir yordayıcısı olduğunu ortaya koymuştur. Bu sonuç, bölümlerini kısmen isteyerek seçen öğrencilerin sorgulama becerilerinin düşük olduğunu göstermektedir.

Sonuç ve Öneriler

Bu çalışmada, katılımcı öğrencilerin sorgulama becerileri puanları yüksek düzeyde bulundu. Çalışmada kullanılan ve öz değerlendirme ölçeği olan bu ölçek, öğrencilerin sorgulama becerileri ile algılanan akademik başarı, bölümü isteyerek seçme ve lisansüstü eğitim alma isteği değişkenleri arasında pozitif ilişkiler ortaya koydu.

Bu öğrenciler muhtemelen bölümlerine ilgi duyan, yatkınlıkları olan ve dolayısıyla öğrenmeye karşı olumlu tutum sergileyen bireylerdir. Öğrencilerin başarılı olmaları ve alanlarına katkıda bulunmaları için öncelikle o alana yatkınlıkları olması ve alanlarına ilgi duymaları gerekir. Öğrenciler mutlu olduklarında ve akademik konularda çalışmaktan zevk aldıklarında, o alandaki başarıları artar. Bu durum sevdikleri veya istedikleri alanda uzmanlaşan öğrencilerin daha yüksek düzeyde sorgulama becerilerini açıklar. Çalışmanın sonuçları, öğrencilerin ilgi alanlarına göre bölümlerini seçmelerinin önemini ve bu bağlamda, özellikle K12 sürecinde doğru yönlendirmenin önemini ortaya koymuştur. Öğrenciler için planlanmış ders içi ve ders dışı etkinlikler düzenlenebilir. Böylece, öğrencilerin bölüme olan ilgisi ve tutumları artırılarak sorgulama becerileri de geliştirilebilir. Ayrıca, üniversite eğitiminde sorgulamaya dayalı öğretimin teşvik edilmesi de sorgulama becerilerinin gelişimini destekleyebilir. Yükseköğretim kurumlarını güçlendirmenin etkili bir yolu, öğrencilerin gelecekte karşılaşabilecekleri belirsizliklerle başa çıkabilmeleri için onları hazırlayacak ileri beceriler geliştirmelerine yardımcı olmaktır. Son olarak, akademik başarıdaki artışın doğrudan sorgulama becerilerini etkileyip etkilemediği konusunda daha derinlemesine araştırmalar yapılmalıdır. Araştırmacılar, öğrencilerin sorgulama becerilerinin gelişimini kolaylaştırmada öğretmen bilgisi, inançları ve uygulamalarının rolünü inceleyebilirler.