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Ethical Reasoning in STEM Disciplines

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Abstract
In this study, it was aimed to determine ethical reasoning of lecturers in STEM disciplines in terms of several independent variables (gender, working another institution, age, academic title, academic discipline, service period). This study was designed as a survey research. Lecturers in STEM disciplines in Kahramanmaras Sutçuimam University were selected as participants of the study. ‘‘Ethical Reasoning Instrument (ERI)’ which was developed by Titus, Zoltowski, Huyck, and Oakes (2011) was used in order to collect data by adapting into Turkish. Data were analyzed by the help of independent sample t-test, one-way ANOVA and Kruskal-Wallis tests. The findings indicated that for all independent variables there were no statistically significant difference ($p>.05$) in ethical reasoning of lecturers. As an interesting result, it was determined that lecturers in engineering discipline have less ethical awareness than lecturers in medicine and science disciplines.
Keywords: STEM, STEM Disciplines, Ethics, Ethical Reasoning.

1. Introduction

In recent years, scientific and technological developments affected countries’ economic, educational, political and social structure and caused to reveal new approaches. From education perspective, STEM education is the best example of this situation. STEM is an approach which puts information and skills related to science, technology, mathematics and engineering and engineering design in the center and aims to make students have problem solving skills in collaboration among disciplines (Buyruk & Korkmaz, 2016; Bybee, 2010b; Dugger, 2010; Rogers & Porstmore, 2004). STEM education is a teaching system including integration among science, technology, engineering and mathematics (Akgündüz, Ertepınar, Ger, Kaplan Sayı, & Türk, 2015b; Bybee, 2010). STEM education has emerged in 1990s (Bybee, 2010). Number of studies in STEM education has increased by the publication of Next Generation Science Standards by United States of America in 2013 (Baran, Canbazoğlu Bilici, & Mesutoğlu, 2015; Yager & Brunkhorst, 2014). STEM focuses on forming skills such as research, design, problem solving, collaboration and efficient communication efficiently in order to make students to obtain these skills since it contains different disciplines (Buyruk & Korkmaz, 2016). When the curricula of the schools in Turkey were examined, it can be seen that STEM disciplines are taught separately. However, integration of the disciplines provides to see the whole not part. Under favor of STEM education students can assess the encountered problems from different perspectives. It is necessary for a country to place STEM in education system in order to have a say in scientific and economic fields (Lacey & Wright, 2009). Moreover, to have competitive power of a country in international fields, STEM education has a strategic importance (Çorlu, Capraro & Capraro, 2014). Researchers who advocates starting to give STEM education in elementary levels claim that students’ problem solving skills will enhance by this way and the number of the students who plan to build a career in these disciplines will increase (Honey, Pearson & Schweingruber, 2014).

Turkey’s 2023 vision and strategic aims determined by Ministry of National Education reveal that it is necessary to describe STEM education countrywide (Çorlu, Adıgüzel, Ayar, Çorlu, & Özel, 2012). However, studies through this purpose are not available in sufficient amount (Çavaş, Bulut, Holbrook & Rannikmae, 2013; Çorlu, et al. 2012; Marulcu & Sungur, 2012). For this reason, reasoning for STEM education of society and especially lecturers working in universities should be increased. In related literature (National Research Council [NRC], 2011; Schmidt, 2011), it is stated that the reason of lack of individuals who will address the need of countries’ today and tomorrow is explained as failure in STEM fields and the decrease in number of graduates in these fields (Buyruk & Korkmaz, 2016). In order to raise individuals who will have an important role for countries’ future, to increase the awareness and reasoning in STEM subjects should be increased.

The resource of the problems experienced in STEM disciplines is the lack of professional ethics behaviors. As one of the branch of philosophy, ethic comes from Greek and *ethos* word. Ethic means that behaviors appropriate to moral norms accepted by the society (Şimşek & Altınkurt, 2009). Through ethic, an action is evaluated from the concepts of moral, qualitative, necessity and allowance (Pieper, 1999). In the base of

the ethic discussion, there are the reasons of making valuable or unvaluable of people actions (Pehlivan & Aydın, 2001). According to Cevizci (2002), ethic is a philosophy discipline and principles theory that gives meaning to life, and puts alternative values, describes life rules clearly instead of current values, fights for making real a certain living ideal and critizes live off own society.

Nowadays, ethic is in an important point for many professional and social areas from business world to academics and health. It affects not only societies' today but also their past and future (Smith, Fulcher &, Sanchez, 2015). For this reason, in STEM disciplines the level of ethic and ethical reasoning's of the individuals have to be increased in social dimension. In recent years, students' solving the complex problems by using their ethical reasoning skills is mentioned as international research subject. According to a study, level of ethical reasoning has a very critical importance for a candidates' carrier success (Association of American Colleges and Universities, 2013: 1). Dalton and Crosby (2011) also stated there are similar situations for the individuals who want to make career in higher education. Ethical reasoning skills to be gained in university level, increase the responsibility of the individuals to the society. At the same time, it will help them to overcome the ethical problems while they perform their professional jobs. The increase of social and cultural efficiency of STEM disciplines caused ethical complexity. This situation increases the importance of the ethical reasoning levels of the individuals. For example, Titus, Zoltowski, Huyck, and Oakes (2011) stated that although engineers try to give importance to safety for professional codes of ethics, the degree of this implementation is discussible and it remains as in only their personal efforts and skills.

The lecturers in STEM disciplines have also important responsibility to their students as giving ethical reasoning skills and transfer it into their profession. For this reason, to investigate especially the ethical reasoning level of the lecturers in STEM disciplines becomes an important issue for this study. When the related literature was examined there are both international and national studies. In an international study for example, a scale which aims to ethical reasoning skills in an action was developed and validity and reliability were validated. Another developing scale study was conducted by Titus, Zoltowski, Huyck and Oakes (2011) and that scale provides to evaluate ethical reasoning of STEM disciplines from different perspectives. Martin and Kullen (2006) conducted a literature review study on continuity and ethic dilemma with meta analytic method. Chan and Leung (2006) researched the effect of personal factors on accounting students' ethic sensitivities and ethical reasoning skills. Goethals, Gastmans and Casterla (2010) rewieved the related literature on ethic reasoning and behaviors in nursing profession. Nolan and Smith (1995) investigated and compared the ethic conscious of freshmen in nursing, dentistry and medicine faculties.

In one of the national studies, Aydın, Sayek, Karaoğlan ve Büken (2006), investigated the clinical doctors' ethical knowledge and awareness. Aydın, Demirkasımoğlu and Alkın (2012) also researched the academic ethic perceptions of academicians in engineering, medicine and education. Öncer and Yıldız (2012) examined the effect of ethic climate on the relation of personal identity and organizational identification of employees of a leading multinational insurance company in Turkey. Similarly, Elçi and Alpkan (2009) investigated the employees of telecommunication firms' profession ethic and the effect of ethic climate on working satisfaction. Yılmaz, Yıldırım and Bahar (2015) focused on professional ethic perception of independent accountant and financial advisors. Different from these studies, Gökçe (2015) researched teachers' ethic discriminations.

The related literature indicated that any study conducted to determine ethical reasoning levels off the lecturers in STEM disciplines could not reached. However, to investigate this issue is very important since the academicians working in these disciplines are in an active point for countries' both scientific and economic future. Additionally, compared to the international studies, there is a limitation for the place and importance of ethic education in higher educations in Turkey (Bayraktaroglu & et al., 2005). By this study, to make a snowball effect and provide awareness to increase ethic reasoning levels starting from the lecturers in STEM fields can be possible.

1.1. Purpose of the Study

In this study, it was aimed to reveal ethical reasoning of lecturers working in STEM fields in Kahramanmaraş Sütçüimam University and their ethical reasoning difference in terms of different variables in decision making process. For these purposes, the following research questions were determined:

- Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of gender?
- Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of worked for another institution?
- Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of age?
- Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of academic title?
- Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of academic discipline?

- Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of service period?

2. Method

2.1. Research design

In this study, survey design, one of the descriptive research approaches, was used. Survey design is description of information about the related population quantitatively by using data obtained from the sample selected from the population (Bursal, 2014).

2.2. Data collection tools

For data collection, *''Ethical Reasoning Instrument (ERI)''* which was developed by Titus, Zoltowski, Huyck, and Oakes, (2011) was used by translating to Turkish. First, this scale was translated from English to Turkish by academicians who were expert in language field. Different translations obtained from the academicians were collected and the questions and the statements in the scale were examined. Conflicting statements were again discussed and agreement was formed. Then, items in Turkish scales were translated to English by different language experts. The first English version of the scale and the last version were compared and any difference between the two was not determined. Thus, the Turkish version of the scale was used in this study in order to collecting data. This scale includes a scenario with ethical dilemmas, 12 Likert type questions related to the scenario and 4 importance preferred questions. In the scale there were two confirmatory questions thus, these questions were removed from the scale and the assessment was conducted through the ten questions.

2.3. Data analysis

IBM SPSS 21 Statistics program was used for analyzing the obtained data. In assessment of the items 5-Likert type scoring between "(1) not very important" and "(5) very important" was used. For analysis of the data, independent sample t-test, one-way ANOVA, and Kruskal-Wallis test were used. Additionally, data were analyzed in .05 significance level and percentage, frequency, mean, and standard deviation values were presented.

2.4. Participants

60 lecturers working in Kahramanmaras Sutçuimam University in STEM fields participated the study. Convenience sampling strategy was used to select the participants due to time and energy limitations. Convenience sampling strategy provides to prevent losing time, working power and money during sampling selection (Büyüköztürk, 2015). Demographics of the participant lecturers were presented in Table 1.

Table 1. Demographics of the participants

		F	%
Age	20-29	8	13.3
	30-39	20	33.3
	40-49	20	33.3
	50-59	10	16.7
	60-59	2	3.3
Gender	Female	16	26.7
	Male	44	73.3
Academic Title	Doctor	13	21.7
	Assistant Professor	21	35.0
	Associate Professor	9	15.0
	Professor	17	28.3
Service period	1-10 years	24	40.0
	11-20 years	12	20.0
	21-30 years	19	31.7
	30 + years	5	8.3
Worked for another institution	Yes	22	36.7
	No	38	63.3
Academic Discipline	Science	15	25.0
	Engineering	28	46.7
	Medicine	17	28.3
Total		60	100.0

3. Findings

In this study, the effects of several variables (gender, worked for another institution, age, academic title,

academic discipline, service period) on ethical reasoning of the lecturers in STEM fields were investigated.

First, the answer of the question "Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of gender?" was investigated. The results of the independent sample t-test were given in Table 2.

Table 2. The results of t-test for gender variable

	Gender	N	$\bar{X}$	sd	t	p
Scale	Female	16	2.90	58	-.455	.651
	Male	44	3.00			

*p<0.05

According to the results in Table 2, there was no significant difference in lecturers' reasoning scores in terms of gender (t (58) = -4.55; p>0.05). It can be said that gender is not an effective factor for ethical reasoning of lecturers in STEM fields. Additionally, while female lecturers' mean score of ethical reasoning is ($\bar{X}$=2.90), mean score of male lecturers is ($\bar{X}$=3.00). When female and male lecturers' mean scores were compared, it can be said that female lecturers' ethical reasoning is less than male lecturers' ethical reasoning.

In the study, the answer of the question "Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of worked for another institution?" was investigated. The results of the independent sample t-test were given in Table 3.

Table 3. The results of t-test for worked for another institution variable

	Worked for another institution	N	$\bar{X}$	sd	t	p
Scale	Yes	22	2.88	58	-.728	.469
	No	38	3.03			

*p<0.05

According to the results in Table 3, there was no significant difference in lecturers' reasoning scores in terms of worked for another institution (t (58) = -.728; p>0.05). It can be said that worked for another institution or not is not an effective factor for ethical reasoning of lecturers in STEM fields. Additionally, while mean score of ethical reasoning of lecturers who did not work for another institution is ($\bar{X}$=3.03), mean score of ethical reasoning of lecturers who worked for another institution is ($\bar{X}$=2.88). When these mean scores were compared, it can be said that lecturers who did not work for another institution before have higher ethical reasoning is than the others.

In the study, the answer of the question "Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of age?" was investigated. The results of one-way ANOVA test were given in Table 4.

Table 4. The results of one-way ANOVA test for age

		Sum of squares	sd	Mean of squares	F	p
Scale	Between Groups	2.586	4	.647	1.103	.365
	Within Groups	32.244	55	.586		
	Total	34.830	59			

*p<0.05

According to the results in Table 4, there was no significant difference in lecturers' reasoning scores in terms of age [F(4,59)=1.103; p>0.05]. It can be said that age is not an effective factor for ethical reasoning of lecturers in STEM fields.

In the study, the answer of the question "Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of academic title?" was investigated. The results of one-way ANOVA test were given in Table 5.

Table 5. The results one-way ANOVA test for academic title

		Sum of squares	sd	Mean of squares	F	p
Scale	Between Groups	1.497	3	.499	.838	.479
	Within Groups	33.333	56	.595		
	Total	34.830	59			

*p<0.05

According to the results in Table 5, there was no significant difference in lecturers' reasoning scores in terms of academic title [F (3,59)= .838; p>0.05]. It can be said that academic title is not an effective factor for ethical reasoning of lecturers in STEM fields.

In the study, the answer of the question "Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of academic discipline?" was investigated. Frequency, mean score, standard deviation and the results of one-way ANOVA test were presented in Table 6 and Table 7.

Table 6. Frequency, mean score, standard deviation values according to academic discipline

Academic discipline	N	$\bar{X}$	SS
Science	15	3.26	0.77
Engineering	28	2.83	0.73
Medicine	17	2.98	0.78
Total	294	2.98	0.76

Table 7. The results one-way ANOVA test for academic discipline

		Sum of squares	sd	Mean of squares	F	p
Scale	Between Groups	1.788	2	.894	1.542	.223
	Within Groups	33.042	57	.580		
	Total	34.830	59			

*p<0.05

According to the results in Table 7, there was no significant difference in lecturers' reasoning scores in terms of academic discipline [F (2,59)= 1.542; p>0.05]. It can be said that academic discipline is not an effective factor for ethical reasoning of lecturers in STEM fields. When Table 6 was examined, it can be deduced that ethical reasoning of lecturers working in engineering discipline were less than the others.

In the study, the answer of the question "Is there a difference in ethical reasoning of lecturers working in STEM fields in terms of service period?" was investigated. Since the obtained data did not show homogeneity, Kruskal-Wallis H test was conducted. The results were presented in Table 8.

Table 8. The results Kruskal-Wallis H test for service period

	N	Mean Rank	Sd	X^2	p
1-10 years	24	32.67			
11-20 years	12	27.83	3	1.628	.653
21-30 years	19	31.42			
30 + years	5	23.00			
Total	60				

*p<0.05

According to the results in Table 8, there was no significant difference in lecturers' reasoning scores in terms of service period (X^2=1.628; p>0.05). It can be said that service period is not an effective factor for ethical reasoning of lecturers in STEM fields.

4. Conclusion and Discussion

In this study, it was aimed to reveal ethical reasoning of lecturers working in STEM fields in Kahramanmaras Sutçuimam University and their ethical reasoning difference in terms of different variables in decision making process. Data were analyzed by calculating percentage, frequencies, and standard deviations. Additionally, to investigate the effect of the independent variables such as gender, worked for another institution, age, academic title, academic discipline, and service period on the lecturers' ethic reasoning, independent sample t-test, one-way ANOVA and Kruskal-Wallis tests were conducted.

There was no statistically significant difference on the participant lecturer's ethic reasoning levels in terms of gender. Thus, gender is not an effective factor on lecturers' in STEM disciplines ethic reasoning. Similar to this finding, Aydın and et al., (2006) found that gender has no effect on clinical doctors' ethic knowledge and awareness. Chan and Leung (2006) also reached the similar results accounting student. Additionally, it was found that male lecturers have more ethic reasoning levels compared to female lecturers. On the contrary, Rest (1983) claimed that women have more ethic reasoning level than men.

There was no statistically significant difference in lecturers' ethic reasoning levels in terms of worked for another institution. It can be said that worked for another institution or not is not an effective factor for ethical reasoning of lecturers in STEM fields. However, it is interesting that lecturers worked in only universities have more ethic reasoning level. According to this result, it can be said that working in university increases the ethic reasoning level of lecturers in STEM disciplines.

There was no statistically significant difference in lecturers' reasoning scores in terms of age. It can be said that age is not an effective factor for ethical reasoning of lecturers in STEM fields. Similar to this, Chan and Leung (2006) there was no significant difference in accounting students'' ethic reasoning levels in terms of age variable. Shaub (1989) and Karcher (1996) also found similar results and these also support the finding of this study.

According to the results, there was no significant difference in lecturers' reasoning scores in terms of academic title. It can be said that academic title is not an effective factor for ethical reasoning of lecturers in

STEM fields. However, Aydın and et al. (2012) found that associate professors and assistant professors have higher ethic responsibility and reasoning.

There was no statistically significant difference in lecturers' reasoning scores in terms of academic discipline. It can be said that academic discipline is not an effective factor for ethical reasoning of lecturers in STEM fields. However, when the mean scores were examined, it was seen that lecturers in engineering discipline have less ethic reasoning level compared to lecturers in medicine and science disciplines. This is an interesting result. This is consistent with Aydın and et al. (2012)'s results. They also found that lecturers have more ethic responsibility and reasoning levels than lecturers in engineering discipline.

Last, there was no statistically significant difference in lecturers' reasoning scores in terms of service period. It can be said that service period is not an effective factor for ethical reasoning of lecturers in STEM fields. In contrast, Yılmaz and et al. (2015) found that service period has an effect on accountant and financial advisors' ethic awareness. They claimed that when the service period increases professional ethic awareness increases.

Consequently, it can be concluded that there is a need for new studies to increase ethic reasoning levels of the lecturers in STEM disciplines. Additionally, there could be other factors which can affect the ethic reasoning level thus, these factors can be investigated and analyzed for their effects. Lecturers in STEM disciplines have more responsibilities to increase the countries' efficiencies in economic, scientific and technological areas. For his reason, the importance and the efficiency of ethic education should be increased starting from the lecturers in STEM disciplines.

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