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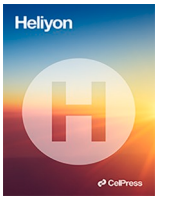

Investigating research students' perceptions about statistics and its impact on their choice of research approach

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A B S T R A C T

In the information society, there is a vast amount of data that needs to be analyzed quantitatively. The ability to perform quantitative analysis based on statistical thinking and data mining, is becoming extremely important. It is important that research students develop positive attitude towards both qualitative and quantitative research approaches. But many research students try to avoid applying quantitative methods in their research and prefer to rely on qualitative research approach due to lack of interest and confidence in statistical skills. This research aims to explore if research students' choice of research approach is affected by their attitude towards Statistics. 81 research students from three different universities participated in a survey in which there was one open ended question. Quantitative data from the survey was analyzed by using cluster analysis and independent sample *t*-test was applied to examine differences in the attitudes of masters and doctoral research students. Other data analysis methods, such as cross-tabular analysis, chi-square and ANOVA tests were also applied. Responses to open ended question were analyzed qualitatively by detecting the themes, such as, focus on technique, data or meaning.

This study found that students pursuing postgraduate degrees in social science streams are not very keen on using a quantitative research approach. Masters students' attitudes towards statistics are different than the doctoral students. Findings of our research indicate that the majority of students who think that statistics is only about numeric methods, prefer to go away from it and choose a qualitative approach. Based on the findings, recommendations for changes in curriculum are presented.

1. Introduction

Understanding statistical methods of data analysis and ability to interpret quantitative information is a pre-requisite for conducting quantitative research. Regardless of the study field, importance of statistical knowledge is growing in the light of emerging big data. It was found that students see statistics and quantitative topics in general as being more difficult than other domains, with negative attitudes often being the main obstacle [1]. Several studies have shown the relationship between students' attitudes toward quantitative methods and their performance as well [1,2]. But many research students try to avoid applying quantitative methods in their research and prefer to rely on qualitative research approach as supported by Refs. [3,4]. Some researchers confirmed that student motivation, teacher's influence, understanding statistics and aptitude for data analysis had a significant impact on proficiency in quantitative research [5]. In another similar study researchers found that students' achievement in statistics courses depends on general resourcefulness, statistical self-efficacy, and attitudes [6,7]. It was found that 70% post graduate research students face difficulty in understanding statistical information presented in research papers. For many students, learning statistics is like learning a new language due to its symbolic representation. Students of non-technical majors, such as psychology, education, and business, often dislike statistics courses or are afraid of taking those courses [8]. In Ref. [9] the term perception is defined as overlapping between cognitive and non-cognitive factors. Non cognitive factors include attitude towards statistics which can be judged from their perceived

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knowledge about career value, interest in learning and willingness to do efforts to achieve mastery of statistics [10–13]. Researchers in statistics education have started examining impact of students' perceptions of statistics on their proficiency.

In most of the postgraduate research programs students are expected to complete at least one statistics course successfully. Statistics is also a compulsory course for other non-technical majors, such as psychology, business, and health sciences. Students take the compulsory course with a wide range of perspectives on what statistics is about [14]. Although statistics is a branch of mathematics it involves other activities which require judgment [9,15]. Some researchers examined students' awareness about what skills are required to learn statistics and their approach to master these skills. Based on the results of their empirical study, they determined the following three themes of students' definition of statistics: focus on technique, focus on data and focus on meaning [13]. When students focus on the data and meaning, they can see the link between statistical knowledge and research methods. If they perceive statistics as only a numerical or a technical activity, then they may not see its role in the research. Lack of confidence in doing statistical analysis may lead to avoidance of quantitative research approach. A lot of research is done about undergraduate students' perceptions about statistics [8–13], but very little research is found about postgraduate research students' perceptions about statistics. Currently, there is no research conducted that investigates perceptions of research students about statistics, in the United Arab Emirates.

This paper investigates research students' perceptions of knowledge and skills of statistics as a subject, their attitude towards statistics and the impact of these on their choice of research approach. Scope of this research is limited to investigate these perceptions of students who are in early stage of formulating their research proposal as a requirement of a research degree. Findings of this study will reveal perceptions of research students in the United Arab Emirates which will lead to understanding of necessary changes in the research method courses.

1.1. Research questions

This research study aims to investigate the following research questions:
Research question 1: How do research students understand the meaning of statistics?
Research question 2: Which factors determine research students' attitudes towards statistics?
Research question 3: Are the attitudes toward statistics different for masters and doctoral students?
Research question 4: Does the mathematics cognitive competence affect the attitudes toward statistics?
Research question 5: Do the determining factors of attitudes toward statistics have an impact on the choice of research methods?

1.2. Purpose and rationale of the study

The investigation undertaken in this study will identify why research students are not very keen to use quantitative research approach. Identification of barriers will help universities redesign the curriculum and build overall confidence in students about statistics and its application in quantitative research methods.

This paper is organized into following sections, literature review and conceptual framework, research approach and methodology, data analysis and results, and discussion and conclusion.

2. Literature review and conceptual framework

In the first subsection, review of theoretical framework used in the research related to statistics education and review of empirical research are presented. In the second subsection an overview of the proposed conceptual model is presented.

2.1. Literature review

Statistics is not only considered as a specific domain of knowledge but also as a collection of thinking processes [16]. [17] identified the following five processes which reflect students' understanding of statistics: the recognition of the need for data, process of extracting meaning from numbers (transnumeration), the consideration of variation, reasoning with statistical models, integrating statistical and contextual information. A framework of mental models based on these five processes is given in Ref. [18]. All five processes except the process of transnumeration, are based on students' prior knowledge of statistics. These five processes are observed in analyzing how students learn statistics. This model is a part of the study's theoretical framework as it relates to cognitive aspects of statistics education. This also connects, in contemporary research, to attitudes toward statistics which has received increasing attention in statistics education. Students' attitudes towards a subject lead to academic success [19–22].

Perception towards statistics can be defined as 'a disposition to respond favorably or unfavorably to objects, situations or people related to statistics learning' [10]. Earlier use of statistics in the form of academic instruction was mostly conventional. The primary focus was on probability theory and on specific statistics procedures. Statistics was mainly considered from an angle of mathematics [23]. In majority of the scenarios, students were expected to rote memorize statistical theories and apply those procedures in typical contexts [24]. Advent of computers in 1990s, made revolutionary changes in statistics instructions. Statistical software tools enhanced statistical applications and reduced the overemphasis of mathematics in statistics courses. Presently, the notable changes have been executed in most of statistics courses as more technology tools are available. Today, many hardware and software devices are available for data analysis and simulations [23]. Accordingly, the goal of statistics education tends to emphasize more on conceptual understanding and less on mechanics of the mathematical procedures. Statistics should not be only practiced as mandatory courses for university students but should also be treated as a tool to solve real life problems [6]. The reports of political elections, sports games,

advertisements, census records, weather forecasts, and many situations, which we come across everyday use basic statistics knowledge [23].

While undertaking the course on statistics, students must be made to believe that understanding and use of statistics is far more applicable in their professional and personal lives. They should be oriented towards the need to learn statistics so that they can willingly invest their time and efforts to learn statistics. This will enable them to learn statistical thinking skills and realize that statistics is not easy but it also is not too difficult to learn [11,25]. Once students develop negative attitudes towards statistics, their learning and adoption of statistical thinking as well as their achievement in such courses also get influenced. Due to negative attitudes, the students who even complete the course often feel dissatisfied with the experience [25]. Some students reveal a positive attitude towards statistics, but evidence reveals that unfavorable responses far outweigh any favorable responses [26,27]. Frequently, students from non-technical major, perceive statistics as one of the biggest hurdles they face as graduate students. They perceive statistics-related courses as the most dreadful in their entire curriculum and these courses are an extremely burdensome experience for them. Many students in the social and behavioral sciences tend to experience a course in statistics as intimidating and/or feel in-sufficiently competent in order to acquire the necessary conceptual understanding [28,29]. Substantiation of this can also be outlined to the titles of some statistics references such as 'Statistics anxiety over learning statistics'. There are few research studies that showed that attitudes toward statistics contribute to the success in statistics courses [10,30,31]. The importance of attitudes in the context of introductory statistics courses is widely recognized [11,32]. Such negative attitudes are often considered a major obstacle for effective learning. One explanation is that students' anxiety towards statistics can be due to some negative experiences in mathematics and statistics. Apart from that, when students do not recognize value and usefulness of statistics in their future careers, they are non-appreciative. Some students realize that they are not sufficiently confident and competent in mathematics to attend university level statistics units and even when they do, their low self-confidence creates negative feelings during their course of study.

There are several research studies focusing on the gender differences regarding students' performance and attitudes toward statistics. A key study [33] published a meta-analysis of studies investigating the gender differences on achievement in statistics and reported that the average effect size d = .08, was in favor of the female students. As found by Ref. [34] male students had more positive attitudes towards statistics than the female students. Contrary to this study [35], reported no significant differences among gender when using the statistics. Recent research showed that attitude of male and female students slightly differs towards their affective and cognitive competence [14,36,37].

The current research is examining non-cognitive factors such as perceptions and attitudes towards statistics. This research study is not to examine how students learn statistics but to examine if students have attained moderate efficiency in the thinking processes which is necessary for getting confidence and proficiency in statistics.

There can be other visible demographic factors or invisible intrinsic factors which may affect students' attitudes toward statistics and may affect student choices of research approach. As mentioned earlier, the existing research literature reports findings of research done on population of students from western countries, but not done particularly on the population of research students in the Middle East. This research tries to fill this gap in existing pool of empirical research.

This research examines demographic factors, such as degree level and mathematics cognitive competence as well as finds groups of students with similar attitudes. After narrowing the focus of this research, a conceptual model is presented in the next subsection.

2.2. Conceptual model

Fig. 1 represents the conceptual model of this research. It is based on the theory of statistics education and findings from previous empirical research [4,5,16].

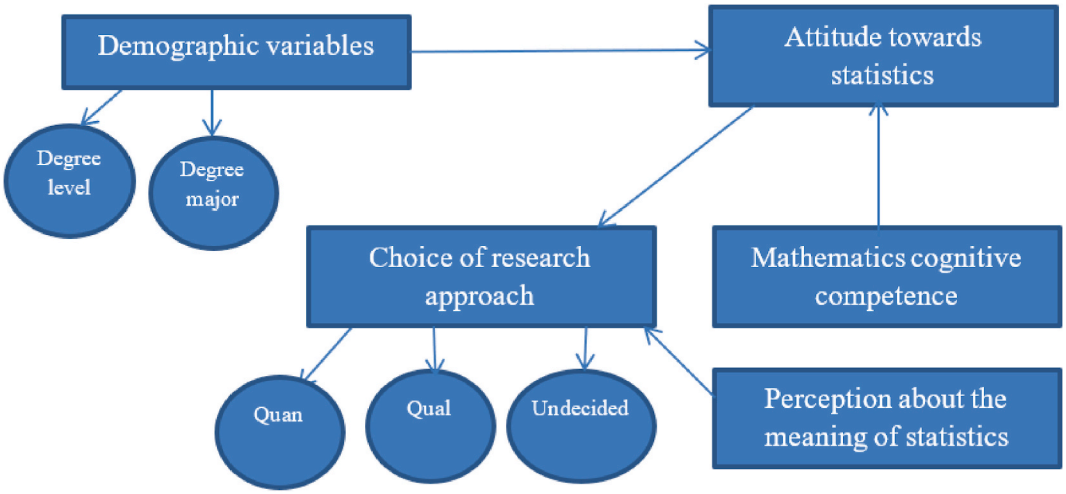

Fig. 1. Conceptual model.

Students in their early semesters of research degrees are not able to decide their research approach for many reasons, such as not having a clear idea about the research topic, not having confidence about one or both research approaches. It will be important to determine the percentage of such students and the barrier they face in deciding their research approach, so that timely support can be provided to them.

3. Research approach and methodology

This section presents the research study's approach and methods used to answer the main question of the study which focuses on why research students are not very keen to use quantitative methods.

3.1. Research approach

This is an interpretivist study in which a quantitative research approach is taken. This study design is pre-experimental research using a survey in a cross-sectional analysis. Convenience sampling method was adopted to collect data as the scope of this research is limited to investigate perceptions of students, currently studying research methods and who are in the early stages of completing their research degree. Survey instrument was sent to all students registered in course of research methods in the Ph.D. and master's program. Out of total 156 registered students, 82 completed the survey. Response rate was 52%.

3.2. Site and participants

This study was conducted at three different Universities in the United Arab Emirates. Out of total 81 participants, 59 students were Masters students, and 22 were doctoral students. 39 participants were male and 42 participants were female. 40 students were from a science and engineering stream, 12 were from business, 22 were from education and 7 were from other degrees such as psychology.

3.3. Data collection methods and instrument

A survey instrument adapted from Ref. [19] is used for collecting data. The instrument consists of demographic questions about campus, gender, level of degree (Masters or Doctoral) and degree major (Engineering, Education, etc). There are 26 questions using a Likert scale of 1–7. The coding is as follows: 1: Strongly Disagree, 2: Disagree, 3: Mildly disagree, 4: Neither agree nor disagree, 5: Mildly agree, 6: Agree, 7: Strongly agree. Responses for negatively worded items were recoded.

The last question in the instrument is open ended, which is coded numerically after analyzing it qualitatively. Survey was administered online as well as on paper.

3.4. Reliability and validity analysis

Reliability analysis showed that Cronbach $\alpha \geq 0.74$. Validity of these factors was confirmed by factor analysis. Factor analysis enables researcher to identify and group different variables which address the same underlying concepts. The factor analysis is applicable under the following assumptions: Data are normally distributed and there are linear relationships between pairs of variables.

These assumptions are tested by the two tests Kaiser-Meyer-Olkin and Bartlett's test of sphericity. Pre-requisite tests to measure sampling adequacy and the test of sphericity were performed. The coefficient of the Kaiser-Meyer-Olkin is approximately equal to 0.7 which is acceptable. The p-value for Bartlett's test of sphericity is less than 0.05 which implies that it is significant and further factor analysis can be performed. Principal component method was used for factor extraction and the initial extraction of factors was done by setting eigenvalues over 1. Five factors were extracted from these settings which were rotated using the Varimax method. Since the strength of correlations between variables should not be less than 0.3, in the correlation matrix the coefficients with absolute value less than 0.3 were suppressed. [38, pg 676].

3.5. Ethical consideration

Authors of this paper obtained a written approval from the owner of the survey instrument before administering this survey [19]. All participants were informed about the purpose of the research and assured of their privacy. Informed consent was obtained from the participants. Participation in the research was voluntary and anonymous. The research proposal was approved by research ethics committee at the British University in Dubai on 15-March-2017.

4. Data analysis

Data analysis was done using SPSS 20. Descriptive statistics were found for demographic variables. Reliability analysis and factor analysis was done on for determining the factors of attitude towards statistics. Global variables were calculated by taking average for each factor. K-means cluster analysis was done using these global variables. Two-way ANOVA and independent samples *t*-test were used for testing hypotheses related to research question 3. Cross tab and Chi square analysis were done between cluster number and the research approach to test the hypothesis 4.

4.1. Descriptive statistics

Frequency distribution for categorical variables was calculated and the following results were found.

The following item in the instrument measures the choice of research approach:

Item 5: Which research approach are you going to adapt for your research?

24.6% respondents chose purely quantitative or mixed method with more focus on quantitative research approach. 25.9% have not yet decided their research approach. But the majority of respondents (40%) chose purely qualitative or mixed method with more focus on qualitative research approach.

Item 6 measures perceived mathematics cognitive competence. 12.3% respondents think that they are not very good in mathematics, 29.6% think that they are average but the majority of them (58%) think that they are very good in mathematics.

The following item measures the prior knowledge of statistics:

Item 7: How confident are you that you have mastered introductory statistics material?

Only 13.6% respondents are confident about introductory statistics, such as mean and standard deviation. 35.8% are somewhat confident, and the remaining 50.6% have either never learned these topics or not at all confident.

Seven degree majors were combined into three categories and four research approached were combined into two categories. Civil engineering, architecture, environmental engineering and computer science degree majors were combined into one category as science stream, education and other degrees were combined into one category as social science stream and business was treated as the third category. Research approach 'Mixed method with more emphasis on qualitative' was combined with Qualitative research approach and the 'Mixed method with more emphasis on quantitative' approach was combined with quantitative. This regrouping was done to determine the distribution of research approaches according to categories of degree majors.

Fig. 2 shows that the majority of students from science and business streams prefer to do qualitative research, though quantitative research is more prominent in those subjects.

4.2. Descriptive statistics of global variables

Global variables were calculated by taking averages of all components in each factor. Mean scores for these global variables are given Table 1.

According to the coding mentioned in section 3.3, a mean score 4 indicates neutral agreement and a score below 4 indicates disagreement while a score above 4 indicates agreement. The highest mean score (4.42) is for the factor 4 which represents students' interest in learning statistics and their willingness to take efforts. The least mean score is for the factor 5 which represents students' attitude about relevance and worth of statistics as a subject. It implies that very few students agree that statistics is relevant and appreciate its value in their chosen degree major. The second factor which represents students' attitude about the difficulty of statistics as a subject has mean than 4, which indicates that overall students find statistics difficult.

Normality of these global variables was assessed using the test of normality. Since these variables follow normal distribution, parametric tests were applied. (Refer to the output A-4 in the appendix).

4.3. Independent samples t-test and ANOVA test

The following hypotheses are setup to answer research questions 3 and 4.

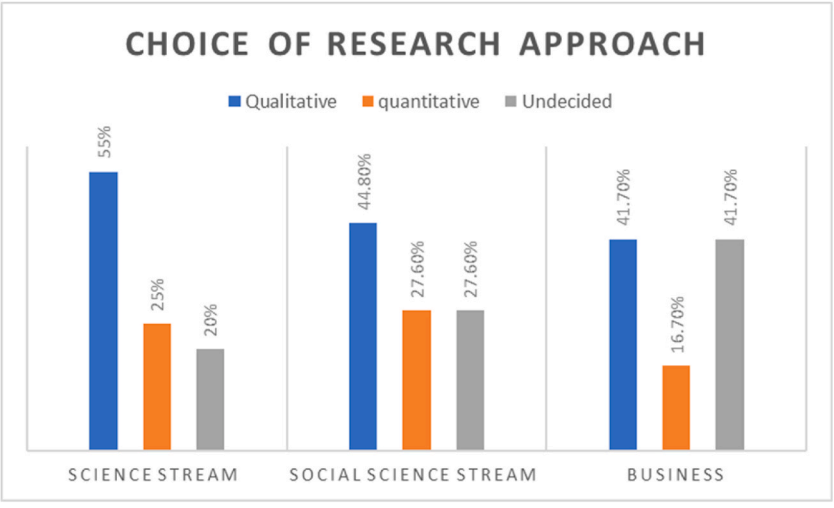

Fig. 2. Distribution of students' choice of research approach in each degree major.

Table 1
Mean score and standard deviation for each factor.

Factor name	Mean	Std. Deviation
Affect (Factor 1)	4.42	1.38
Difficulty (Factor 2)	4.21	1.15
Cognitive competence (Factor 3)	3.54	1.26
Interest and effort (Factor 4)	5.24	.95
Value (Factor 5)	3.99	1.55

Research question 3: Are the attitudes toward statistics different for masters and doctoral students?

$H3_0$: Masters and doctoral students have similar attitudes towards statistics.

$H3_1$: Masters and doctoral students have different attitudes towards statistics.

Since there are only two degree-levels, independent samples *t*-test was applied to test the null hypothesis. Global variables related to five factors were taken as the dependent variables and the variable degree level was taken are the grouping variables. Only the cognitive competence factor differed significantly between masters and doctoral students. The p-value for the difference in the mean score for the other four factors was higher than 0.05.

Research question 4: Does the mathematics cognitive competence affect the attitude towards statistics? Five different hypotheses are tested to examine this research question, each hypothesis relates to different factors measuring attitude, which are *Affect, Difficulty, Cognitive competence, Interest* and *Value.*

$H4A_0$: Students who are very good, average, or weak in mathematics have same level of *Affect.*

$H4A_1$: *Affect* is not the same for students who are very good, average, or weak in mathematics

$H4B_0$: Students who are very good, average, or weak in mathematics face same level of *Difficulty* in statistics.

$H4B_1$: Students who are very good, average or weak in mathematics do not face the same level of *Difficulty.*

$H4C_0$: *Cognitive Competence* is the same for students who are very good, average, or weak in mathematics

$H4C_1$: *Cognitive Competence* is not the same for students who are very good, average or weak in mathematics

$H4D_0$: Attitudes Interest is the same for students who are very good, average or weak in mathematics.

$H4D_1$: Attitudes Interest is not the same for students who are very good, average or weak in mathematics.

$H4E_0$: Attitudes Value is the same for students who are very good, average or weak in mathematics

$H4E_1$: Attitudes Value is not the same for students who are very good, average or weak in mathematics

Since there are three categories for mathematics cognitive competence, one way ANOVA tests were applied. The results of this test indicate that interest and value of the statistics are the same but affect, statistical cognitive competence and the difficulty are significantly different for students with different mathematics cognitive competence. Table 2 shows the F-value and respective p-value for each factor.

4.4. Cluster analysis

Factor analysis enables the researcher to group variables but fails to identify groups of people with similar attitudes. In order to identify such groups, cluster analysis is done [38], pg 686]. In order to determine which groups of students have similar attitudes for each of the five factors, a cluster analysis is applied. Students are classified into clusters based on the mean value of each factor.

In order to understand variations in students' attitude about each factor, given data were classified into three clusters using k-means clustering. K-means clustering is appropriate when there is no prior knowledge about number of clusters. [39], pg 557]. This clustering created three different profiles based on the attitude score. Number of clusters was set equal to the number of research approach choices.

Students in the first cluster have higher scores for affect, interest, and value than the members in the other two clusters, whereas students in the second cluster have the lowest score for difficulty. Students in the third cluster have the highest difficulty score and the lowest score for value.

The mean scores of each variable represent cluster profiles, which are given in Table 3.

From the above table, it can be interpreted that students in cluster 3 have the least scores for all factors compared to students in other two clusters. Probably, they think that they cannot learn statistics but they have moderate appreciation for the value of statistics and interest. Approximately 35% of students are in cluster 2 and they do not appreciate value of statistics in their chosen field. The mean score for factor value is less than 4. Also, their score for cognitive competence is slightly more than 4 which means they think

Table 2
Results of ANOVA test Mathematical cognitive competence and attitude toward statistics.

Factor name	F-value	p-value	conclusion
Affect	6.256	0.003	Reject the null hypothesis
Difficulty	15.635	0.000	Reject the null hypothesis
Cognitive competence	5.457	0.006	Reject the null hypothesis
Interest	0.886	0.416	Do not reject the null hypothesis
Value	1.594	0.210	Do not reject the null hypothesis

they can learn statistics. Only 28% of students which are in cluster 1 have a positive attitude and an interest in learning statistics, but they think that statistics is somewhat difficult and they do not have the ability to learn it.

Table 4 shows distribution of student numbers in each cluster according to their choice of research approach. It can be seen that approximately 43% students in cluster 3 have preference for qualitative approach and only 18% have preference for quantitative approach. In cluster 2, number of students choosing qualitative approach is equal to number of students choosing quantitative approach. In order to examine if the difference in research choices is statistically significant, following hypotheses are examined, which pertain to research question 5.

H_0: Research choices do not depend on the cluster membership

H_1: Students in different clusters have different choices for research approach

This hypothesis is tested using chi-square test because both the cluster membership and the research approach choice are nominal variables. The hypothesis is rejected at 5% level of significance (Pearson Chi-Square value 10.284, $p = 0.036$). The percentages in Table 4 show some interesting facts. Refer to the output (A-6) given in the appendix.

4.5. Analysis of qualitative data

The last item in the survey is an open-ended question which examines the first research question. Total 44 respondents answered this question.

The responses to this item were analyzed qualitatively and a code was assigned according to the following themes [13].

Only 44 (54%) students answered this question. Out of 44 students, 21% expressed either statistics is same as mathematics or not same as mathematics. It was not possible to categorize their responses due to their brief answers. These percentages indicate that the majority of students are not able see the link between statistical techniques and research methods. If the appropriate higher order thinking skills, such creating intrinsic meaning, are developed then students may not think that statistics is just a collection of methods. Refer to Table 5.

Pearson Chi square coefficient is found to be equal to 12.61 with p-value 0.013. Chi square analysis shows that choice of research approach differs according to students' understanding of the word statistics. Most students who think that statistics is only about numeric methods, prefer to go away from it and choose a qualitative approach.

5. Discussion

82.6% students in the cluster-1 have chosen their research approach. Though these students have high scores for affect and value, a majority of them have chosen a qualitative research approach. This choice can be attributed to their high score for difficulty.

20% of students in the cluster-2 have not chosen their research approach and 40% of have chosen qualitative approach. They have the lowest score for difficulty. Out of 20% in the undecided category will probably choose a quantitative approach if they develop confidence in learning statistics. Most students who have chosen quantitative approach are in this cluster group. The highest number of students who have not chosen their research approach are in cluster 3 and the mean score for Value is the lowest in this cluster group. If they realize the worth of statistics, they may make efforts to learn statistics and may not find it difficult. This may help them to choose a quantitative research approach.

It can be seen that only 25% of graduate students prefer either purely quantitative or mixed method approaches with more weightage to the quantitative approach, which means the majority of graduate students do not have positive attitude towards quantitative methods. Our findings are consistent with the results found by authors of [13,14]. 49% of students reported that they are confident about basic statistics but only 12.3% of them chose quantitative research approach and 58% reported that they are very good in mathematics but only 25% of them chose the quantitative research approach. It appears that more than cognitive factors, the non-cognitive factors, such as affect and value are influencing students' choice of research approach. This is consistent with the findings presented in Ref. [40]. They found that even after mastering the content knowledge of statistics, students did not appreciate the applicability of what they had learned.

According to Ref. [41], different conceptions or beliefs are not factual things but they still have positive or negative impact on learning. If a student has apperception of lacking mathematical proficiency, he or she may develop difficulties and lack interest in learning quantitative research skills. A belief that research skills are required only in academic filed and not required in other fields is another factor leading to development of negative attitude towards statistics and research skill. In a recently published paper, authors found that many students from social science stream do not perceive statistical skills useful in their career [42].

This study found that students pursuing postgraduate degrees in social science streams are not very keen on using a quantitative research approach. Masters students' attitudes towards statistics are different than the doctoral students. Mathematics cognitive

Table 3
Profiles created by k-means clustering.

Cluster number	Score for Affect	Score for Difficulty	Score for cognitive competence	Score for Interest	Score for Value	Number of students in the cluster
1	5.7	4.12	3.41	5.85	5.52	21
2	4.79	4.89	4.60	5.07	2.57	28
3	3.24	3.16	2.71	5.00	4.23	32

Table 4
Two-way table between cluster number and research approach.

		Research approach categories			Total
Cluster number		Qualitative	Quantitative	Undecided	
1	Count	16	3	4	23
	% within Cluster Number of Case	69.6%	13.0%	17.4%	100.0%
2	Count	12	12	6	30
	% within Cluster Number of Case	40.0%	40.0%	20.0%	100.0%
3	Count	12	5	11	28
	% within Cluster Number of Case	42.9%	17.9%	39.3%	100.0%
Total	Count	40	20	21	81
	% within Cluster Number of Case	49.4%	24.7%	25.9%	100.0%

Table 5
Three themes of students' definition of statistics.

Category name	Basis of the category	Example	% of responses
Gathering: Extrinsic technical	Focus on technique	Statistics is a way to summarize information to aid understanding and collecting data.	37%
Applying: Extrinsic meaning	Focus on data	Meaning of numbers, the process is mathematics but the product is info and knowledge.	21%
Creating: Intrinsic meaning	Focus on meaning	Statistics is a tool in analyzing and interpreting real life events set in a data. This could be an application aid in preparing future plans and a guide for possible actions for whatever purposes it may serve.	7%

competence is also a factor which influences students' attitude towards statistics. K-means cluster analysis found that all five factors impact the choice of research approach.

Perceived difficulty or lack of ability to learn statistics are two factors which can be altered by providing additional support to research students. This can be achieved by redesigning the curriculum or by providing external support to students in the form peer mentoring.

Although students come to the compulsory statistics course with a wide range of perspectives on *what statistics is about*, it is important to make them aware of the possible value of statistics in the research.

Instead of theoretical lecture-based course delivery, skills-based teaching can be adopted when planning for teaching the statistical courses. Moreover, it would be innovative if early introduction to statistical methods was considered in K-12 curriculum. Using different software packages and tools for teaching statistics can be effective as these tools can facilitate visualization of data. Most non-mathematics major students fail to appreciate the true nature of mathematics and statistics when they tedious multi-step calculations. The tediousness of problem solving can be removed with the help of appropriate use of technology and tools [43]. A positive difference in students' attitude after using a simple tool, such as the graphing calculator was found [44]. Some authors [45,46] recommend to use tools only as one of the components of statistics learning environment. Other components, such as providing realistic and motivating data sets for analysis, will help in developing positive attitude towards statistics.

6. Conclusion and implications

This study investigated research students' attitude towards statistics and their possible impact on choosing quantitative research approach. The target population was research students studying the United Arab Emirates. Results of empirical investigations revealed that a small percentage of research students from the target population are ready and willing to undertake quantitative research. One of the barriers in adopting quantitative research approach is lack of statistical skills due to negative attitude. These findings are consistent with similar findings from different geographical context. In an attempt to encourage students to undertake quantitative research and foster right attitude towards statistics and its applications, following recommendations are provided.

7. Limitations and future directions

This research is an empirical investigation. Although the findings cannot be generalized to a different context, the findings can be used to design research method courses which can motivate students to undertake quantitative research approach when necessary.

This study was based on a reasonably sized sample, not all respondents answered the qualitative question. This can be considered as the limitation of this study. In the future work related to this topic this data will be collected carefully.

The same study can be improved in the future research if conducted with a larger sample of participants or if done in a different context, or adding a different variable. Adding variables like achievement and study habits will allow examination of the direct and indirect impact of students' attitudes towards statistics on these variables.

There can be several barriers to why students do not want to take up quantitative research. One of the barriers can be the negative attitude towards statistics. This study focused only on this barrier. For investigating other barriers in using quantitative methods,

further research is required. The unknown barriers can be explored using qualitative research approach, such as interviews.

Author contribution statement

Anita Dani: Conceived and designed the experiments; Performed the experiments.; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper. Elaine Al Quraan: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:First author Dr. Anita Dani was invited to review one article for Heliyon Journal. This paper is submitted as the first author received invitation to submit a paper to the same journal. This paper is submitted after accepting the invitation sent by editors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e20423.

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