Acadlore Transactions on Applied Mathematics and Statistics
https://www.acadlore.com/journals/ATAMS

Analyzing Impact of Effort, Interest and Cognitive-Competence on Statistics Achievement Through Meditation of Self-Concept Statistics

Manar Hazaimeh[1], Abdullah M. Al-Ansi[2*], Jebril AL-hrinat[3], Ghadeer Adwan[4], Aseel Hendi[5]

[1] Faculty of Education, Yarmouk University, 566-21163 Irbid, Jordan
[2] College of Commerce and Business Administration, Dhofar University, 211 Salalah, Sultanate of Oman
[3] Faculty of Education, Arab American University, 12567 Hebron, Palestine
[4] Faculty of Education, Islamic University of Gaza, 20643 Gaza, Palestine
[5] Industrial Engineering Department, The Hashemite University, 214-5212 Zarqa, Jordan

* Correspondence: Abdullah M. Al-Ansi (aalansi@du.edu.om)

Received: 02-28-2024 **Revised:** 04-12-2024 **Accepted:** 04-26-2024

Citation: M. Hazaimeh, A. M. Al-Ansi, J. AL-hrinat, G. Adwan, and A. Hendi, "Analyzing impact of effort, interest and cognitive-competence on statistics achievement through meditation of self-concept statistics," *Acadlore Trans. Appl Math. Stat.*, vol. 2, no. 2, pp. 81–93, 2024. https://doi.org/10.56578/atams020203.

© 2024 by the author(s). Published by Acadlore Publishing Services Limited, Hong Kong. This article is available for free download and can be reused and cited, provided that the original published version is credited, under the CC BY 4.0 license.

Abstract: This investigation was conducted to assess the impact of effort, interest, and cognitive competence on statistics achievement, mediated by self-concept among students. The study engaged 453 students enrolled in a statistics course at Yarmouk University, Jordan, who completed a self-report questionnaire. Path analysis facilitated the examination of both direct and indirect influences exerted by effort, interest, and cognitive competence on statistics achievement, with self-concept serving as a mediator. It was found that effort, interest, and cognitive competence significantly directly affected statistics achievement. Furthermore, self-concept was observed to partially mediate the relationships between each of effort, interest, cognitive competence, and statistics achievement. These results underscore the critical roles of effort, interest, and cognitive competence as predictors of success in statistics. The partial mediation by self-concept suggests its important but not exclusive role in enhancing academic outcomes. This study contributes to educational strategies by highlighting the potential of interventions focused on self-concept enhancement to improve academic performance in statistical education. Implications for educators and policy-makers are discussed in terms of designing effective educational interventions.

Keywords: Effort; Interest; Cognitive competence; Self-concept; Statistics achievement; Jordanian Yarmouk University

1 Introduction

Statistics is an important subject that is widely used in various fields such as business, social sciences, and healthcare. The achievement of statistics is influenced by several factors, including effort, interest, cognitive competence, and self-concept. This paper proposes hypotheses to examine the relationship between effect, effort, interest, and cognitive competence and its impact on statistical achievement through self-concept statistics. Effort, interest, and cognitive competence are factors that are thought to contribute directly to statistical achievement. Research has consistently demonstrated that students who put in more effort, are interested in the subject matter, and possess a high level of cognitive competence tend to perform better academically [1–3]. However, the role of self-concept in the relationship between these factors and statistical achievement is less clear.

Self-concept refers to an individual's self-perception in various areas, including their academic capabilities. Studies have consistently shown that there is a positive correlation between self-concept and academic achievement [4, 5]. Specifically, students with a positive self-concept tend to perform better academically than those with a negative self-concept. Therefore, the paper proposes hypotheses to explore the indirect effects of self-concept on the relationship between effort, interest, cognitive competence, and statistical achievement.

Student achievement is closely tied to cognitive competence, as the latter refers to the mental abilities and processes necessary for successful learning [6]. Researchers have found that students who demonstrate higher levels of cognitive competence typically achieve better grades, perform well on standardized tests, and exhibit strong problem-solving skills [7]. Cognitive competence encompasses a range of skills, including attention span,

memory retention, critical thinking, and information processing [8, 9]. Educators play a crucial role in fostering cognitive competence by providing engaging and challenging curriculum, encouraging active participation in class discussions, and offering targeted interventions for students struggling with specific areas of cognition [10]. By nurturing cognitive competence in students, educators can help them reach their full potential academically and develop strong analytical skills that will benefit them beyond the classroom.

The problem in this study is the understanding of the factors that contribute to academic achievement in the field of statistics. Statistics is a critical subject in many fields, and academic achievement in statistics is an important predictor of success in these fields. Despite the importance of statistics, many students struggle to achieve success in this subject. The study's importance lies in its potential to identify the factors that influence statistical achievement and to provide insights into how these factors can be improved. By examining the direct and indirect effects of effort, interest, and cognitive competence on statistics achievement through the mediating role of self-concept, this study can provide valuable information for educators, policymakers, and researchers to enhance students' academic achievement in statistics. Furthermore, the study can be valuable in the creation of academic interventions and programs that aim to enhance students' statistical achievement. The findings can guide the formulation of effective interventions that focus on improving factors such as students' self-concept and interest in statistics, as well as providing assistance in developing their cognitive competence.

2 Literature Review

2.1 Effort

Effort is defined as the degree of exertion or the amount of energy expended to accomplish a task [11]. It is considered a critical determinant of academic achievement, as it reflects the level of dedication and persistence that students exhibit towards their academic pursuits [12]. In the context of statistics education, effort has been shown to be positively associated with achievement [13]. Githua and Nyabwa [14] found that students' effort was significantly related to their achievement in a statistics course. In addition, a meta-analysis in the study [15] revealed that effort is a strong predictor of academic achievement across a range of subjects, including mathematics. Research has also shown that effort is positively related to academic achievement. For example, Stoeber and Stoeber [16] showed that effort is positively related to academic performance in undergraduate students. Similarly, Hidi and Renninger [15] discovered a positive association between effort and academic performance across multiple academic disciplines.

Effort plays a crucial role in determining student achievement. Research has consistently shown that students who put forth genuine effort tend to perform better academically. When students devote time and energy towards their studies, they are more likely to grasp new concepts, retain information, and apply their knowledge effectively [16, 17]. In addition, putting in effort fosters a strong work ethic and resilience in the face of challenges. Students who are willing to work hard demonstrate perseverance and determination, which are essential qualities for success in academics and beyond [18]. Teachers can also play a pivotal role in motivating students to exert effort by providing engaging lessons, setting high expectations, and offering constructive feedback. Ultimately, the relationship between effort and student achievement underscores the importance of cultivating a growth mindset and fostering a culture of hard work within educational environments. Based on the literature above, the first and second hypotheses were formulated as:

H1: Effort has a direct and positive effect on statistical achievement.

H2: Effort has an indirect effect on statistical achievement through meditation self-concept.

2.2 Interest

According to self-determination theory (SDT), individuals who are intrinsically motivated, i.e., who engage in an activity because they find it interesting, enjoyable, or satisfying, are more likely to perform well and persist in the activity [19]. In the context of education, several studies have demonstrated that interest is a significant predictor of academic achievement, including in the field of statistics [20–22]. High school students who reported greater interest in mathematics achieved higher grades in mathematics and had higher scores on the mathematics section of the SAT. Similarly, Wang and Eccles [23] discovered that high school students who expressed a higher level of interest in math and science were more inclined towards pursuing careers in STEM (Science, Technology, Engineering, and Mathematics) fields. Interest can directly contribute to academic achievement by increasing the student's engagement and enjoyment of the subject matter. It can also indirectly influence academic achievement by shaping the student's self-concept. As a student develops a greater interest in the subject, they may develop a stronger sense of self-efficacy and belief in their ability to succeed, which can further increase their motivation and academic achievement [24–26]. Moreover, research has shown that interest is a key factor in the learning and retention of information [14]. When individuals are interested in a topic, they are more likely to engage in deep processing of the information, which leads to better learning and retention. In the context of statistics, individuals who are interested in the subject are more likely to engage with the material, seek out additional resources, and apply the concepts to real-world problems, which can lead to better performance on exams and assignments [27].

Research has consistently demonstrated that interest is positively related to academic achievement. Several studies have reported that students who are interested in their academic subjects tend to perform better academically [17, 22]. In summary, based on the literature, it is reasonable to hypothesize that interest has a direct and positive effect on statistical achievement. Students who are more interested in statistics are likely to perform better in the subject.

In education, the relationship between student interest and academic achievement is widely acknowledged as a crucial factor in determining success [28]. When students are interested and motivated in a subject, they are more likely to actively engage with the material, participate in class discussions, and seek out additional learning opportunities [29]. This leads to improved comprehension, retention of information, and overall performance in assessments. Research also suggests that when teachers are able to spark student interest through dynamic lessons and relevant real-world applications, it can have a significant impact on student achievement levels [30]. By fostering an environment where students are encouraged to explore their interests and connect them to their learning experiences, educators can effectively enhance motivation and drive for academic excellence among their learners [31]. Ultimately, promoting student interest plays a key role in unlocking potential and facilitating positive outcomes in education.

H3: Interest has a positive and direct effect on statistical achievement.

H4: Interest has an indirect effect on statistical achievement through meditation self-concept.

2.3 Cognitive Competence

Research has suggested that there is a positive correlation between cognitive competence and academic achievement [32]. Cognitive competence is a significant predictor of academic achievement, including in statistics [33]. Cognitive competence can directly contribute to academic achievement by improving the student's knowledge and skills in the subject area. It can also indirectly influence academic achievement by shaping the student's self-concept. As a student develops greater cognitive competence, they may develop a stronger sense of self-efficacy and belief in their own abilities, which can further increase their motivation and academic achievement [34].

Cognitive competence refers to the ability to process and analyze information, solve problems, and think critically. Research has consistently shown that cognitive abilities are strong predictors of academic achievement [35]. Statistics achievement, on the other hand, refers to the extent to which students demonstrate mastery of statistical concepts and skills. Studies have found a positive relationship between cognitive competence and achievement in statistics. For example, Kuncel and Hezlett [36] found that cognitive abilities such as mathematical reasoning and spatial visualization predicted success in statistics courses. Research has consistently demonstrated that cognitive competence is a strong predictor of achievement in mathematics and statistics [37, 38]. For instance, Xu and Schau [39] found that cognitive competence was a significant predictor of achievement in an undergraduate statistics course, even after controlling for other relevant factors such as prior mathematics and statistics achievement, motivation, and self-efficacy.

Furthermore, cognitive competence plays a crucial role in determining student achievement in academic settings. Students who possess strong cognitive abilities, such as critical thinking, problem-solving skills, and memory retention, are more likely to excel in their studies compared to those with weaker cognitive skills [40, 41]. Cognitive competence enables students to process information effectively, make connections between different concepts, and handle complex tasks with ease. Moreover, individuals with high cognitive ability are better equipped to adapt to new challenges and learn new information quickly [42]. Educators can support the development of cognitive competence by implementing instructional strategies that promote critical thinking, encourage active learning, and provide opportunities for students to engage in meaningful problem-solving activities [43]. By fostering cognitive competence among students, educators can help enhance academic performance and prepare individuals for success in both educational and professional settings.

Moreover, according to the cognitive load theory, individuals' cognitive abilities directly impact their ability to learn complex tasks such as statistics [44]. This theory posits that learners' cognitive resources are limited and that they must allocate these resources efficiently to learn effectively. Thus, learners with higher cognitive competence may be better equipped to handle the cognitive demands of statistical tasks, leading to better performance [45].

H5: Cognitive competence has a positive and direct effect on statistical achievement.

H6: Cognitive competence has an indirect effect on statistical achievement through the mediation of self-concept.

2.4 Self-Concept

Self-concept refers to an individual's beliefs and perceptions about their abilities, traits, and characteristics. Previous research has shown that self-concept can influence academic achievement [46, 47]. Self-concept refers to an individual's perception of their abilities, characteristics, and values and has been found to be a crucial factor in academic achievement [48]. Several studies have indicated that self-concept is a significant predictor of academic performance [26, 34, 44, 49]. For example, Marsh and Craven [44] found that self-concept was positively related to academic achievement in mathematics. Furthermore, research has shown that interest is positively related to

self-concept [14, 22]. When individuals are interested in a domain, they are more likely to develop a positive self-concept in that domain, which in turn can lead to greater engagement and achievement [14].

This hypothesis is supported by the self-concept theory, which emphasizes that individuals' beliefs about themselves influence their behavior and academic achievement [50, 51]. Specifically, self-concept refers to one's beliefs and perceptions about their own abilities, characteristics, and values [37]. When individuals perceive themselves as capable and competent in a specific domain, they are more likely to engage in activities related to that domain, persist in the face of challenges, and ultimately achieve success [52, 53].

In addition, self-concept, defined as an individual's perception of themselves, plays a crucial role in student achievement [15]. Research indicates that students with a positive self-concept are more likely to set high academic goals, take risks in their learning, and persist in the face of challenges. On the other hand, students with low self-esteem or negative self-perceptions may doubt their abilities, shy away from challenges, and underperform academically [27]. Therefore, nurturing students' self-concept is essential for promoting academic success. Educators can support students by providing opportunities for success, offering constructive feedback, and creating a safe and inclusive learning environment. By instilling strong self-concepts in students, educators can empower them to reach their full potential and achieve academic excellence.

Students who have a positive self-concept tend to have a more positive attitude towards their academic work and are more motivated to achieve their goals [3]. Moreover, previous research has suggested that self-concept can mediate the relationship between cognitive competence and academic achievement [46, 53]. This suggests that students who have higher cognitive competence may have a more positive self-concept, which, in turn, leads to better academic achievement.

Hypotheses 3 and 4 also relate to social cognitive theory and self-concept theory, as they suggest that interest can directly and indirectly influence academic achievement. Moreover, several studies have shown that self-concept mediates the relationship between effort and academic achievement. For example, Linnenbrink and Pintrich [54] found that self-concept partially mediated the relationship between effort and academic achievement in middle school students.

H7: Self-concept has a direct and positive effect on statistical achievement.

2.5 Research Framework

The theoretical framework for the above hypotheses can be based on social cognitive theory and self-concept theory. Social Cognitive Theory and Self-Concept Theory are both important frameworks for understanding the factors that influence academic achievement. Social Cognitive Theory posits that behavior is shaped by an interplay between individual factors, situational factors, and behavioral factors. According to this theory, personal factors such as effort, cognitive competence, and self-efficacy beliefs can directly and indirectly influence academic achievement. Situational factors, such as the learning environment and social context, can also play a role in shaping behavior. Finally, behavioral factors such as motivation and self-regulation can further influence academic achievement [55]. Self-Concept Theory suggests that individuals' beliefs about their own abilities and qualities can shape their behavior and achievements. According to this theory, self-concept is composed of both the individual's self-esteem and their self-efficacy beliefs. Self-esteem refers to the individual's overall sense of self-worth, while self-efficacy beliefs are their beliefs about their ability to succeed in specific domains, such as academics. These beliefs can be shaped by personal factors such as effort and cognitive competence, as well as situational factors such as feedback from teachers and peers [48].

The hypotheses formulated in the manuscript are consistent with both social cognitive theory and self-concept theory. Hypotheses 1, 2, 5, and 6 suggest that personal factors such as effort and cognitive competence can directly and indirectly influence academic achievement. For example, effort can directly contribute to academic achievement by increasing the amount of time and energy a student devotes to their studies. Effort can also indirectly influence academic achievement by shaping the student's self-concept. As a student puts in more effort, they may develop a stronger sense of self-efficacy and belief in their own ability to succeed, which can further increase their motivation and academic achievement.

3 Methodology

The current study employed a quantitative research design, specifically a path analysis, to investigate the relationships among effort, interest, and cognitive competence on statistics achievement through the mediation of self-concept. The participants were undergraduate students from Jordanian universities taking a statistics course. The sample size was 453, and data were collected using a self-report questionnaire. The questionnaire consisted of 24 items that measured effort, interest, cognitive competence, self-concept, and statistical achievement.

3.1 Measures

The study employed a self-report questionnaire consisting of five scales measuring effort, cognitive competence, interest, self-concept, and statistical achievement. The effort, cognitive competence, and interest scales were adapted from the study [54], while the self-concept scale was adapted from the studies [26, 56]. The statistical achievement scale was adapted from the study [57].

Both online and offline surveys, and the participants were chosen through a random sampling process. The data was collected between January and March of 2023. Measurement validation, confirmatory factor analysis (CFA), and path analysis were performed using SPSS and AMOS 27. The maximum likelihood method was used to conduct a path analysis to examine the direct and indirect impacts of effort, interest, and cognitive competence on statistical achievement through the mediation of self-concept. The mediation effect was tested using a bootstrapping method with 2000 resamples.

3.2 Participants

The study sample consisted of 453 students from a Jordanian Yarmouk University; 58.90% were female, while 41.10% were male. In terms of academic year, the first and second years made up the majority of the sample, accounting for 40.20% and 39.30%, respectively. However, it is noteworthy that there were still individuals in their third year (10.80%) and fourth year or beyond (9.70%) included in the sample.

The distribution by college indicates that 56.10% of individuals were enrolled in the humanitarian college, while 43.90% were enrolled in the scientific college. Table 1 illustrates the demographics of the sample.

Table 1. Distribution of the sample due personal information

Demographic	Item	N	%
Gender	M	186	41.10%
	F	267	58.90%
Year	First	182	40.20%
	Second	178	39.30%
	Third	49	10.80%
	Fourth or more	44	9.70%
Collage	Humanitarian	254	56.10%
	Scientific	199	43.90%

3.3 Exploratory Factor Analysis (EFA)

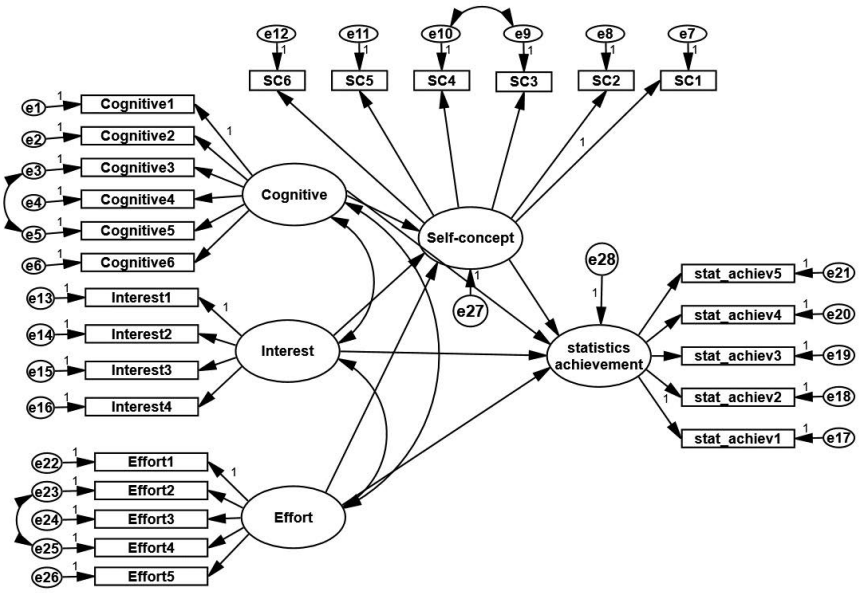

Figure 1. Conceptual framework

A principal component analysis was conducted to identify underlying factors in the measured variables. The analysis fifth's factors with eigenvalues greater than 1, as shown in the screen plot in Figure 1, explain 35.632%,

13.677%, 6.83%, 6.177%, and 4.68% of the variance, respectively [33]. The first factor, named "effort," had high factor loadings on five items related to effort, with factor loadings ranging from 0.372 to 0.871. The second factor, named "cognitive," had high factor loadings on six items related to cognitive engagement, with factor loadings ranging from 0.648 to 0.857. The third factor, named "interest," had high factor loadings on the fourth item related to interest, with factor loadings ranging from 0.728 to 0.927. The fourth factor, named "statistical achievement," had high factor loadings on the fifth's items related to statistical achievement, with factor loadings ranging from 0.598 to 0.717. The fifth factor, named "self-concept," had high factor loadings on sixth items related to statistical achievement, with factor loadings ranging from 0.436 to 0.838.

Table 2. Results of EFA

Measurement Items	Factor Loading	Eigenvalue	Variance Explained
I plan to complete all of my statistics assignments.	0.372		
I plan to work hard in my statistics course.	0.565		
I plan to study hard for every statistics test.	0.864	9.264	35.632
I plan to attend every statistics class session.	0.582		
I plan to review my notes and course materials regularly to reinforce my understanding of statistics.	0.871		
I am confident in my ability to grasp statistics concepts and apply them proficiently.	0.648		
I am making good progress in this statistics course and finding the material easy to follow.	0.676	3.556	13.677
I am skilled at performing statistical calculations accurately and quickly.	0.857		
I am capable of learning and mastering statistics.	0.849		
I have a strong understanding of statistical equations and their applications.	0.848		
I feel comfortable with statistical concepts and am able to use them effectively.	0.850		
I am interested in communicating statistical information to others.	0.927		
I am interested in utilizing statistics.	0.728	1.776	6.830
I am interested in comprehending statistical information.	0.834		
I am interested in learning about statistics.	0.903		
I am a quick learner when it comes to statistics.	0.598		
Statistics is a strong area for me.	0.644		
I believe that learning statistics would benefit me in my daily life.	0.717	1.606	6.177
Achieving success in statistics is important for me to attain my desired job.	0.631		
I consistently perform well in statistics.	0.712		
I excel at solving statistical problems.	0.794		
I am confident in my ability to perform well on statistics tests.	0.838		
I understand the fundamental principles of statistics.	0.754	1.217	4.680
I have a strong grasp of statistical terminology and concepts.	0.557		
My statistical skills are useful for achieving my personal and professional goals.	0.823		
I have a better understanding of statistics than most people do.	0.436		
Total variance explained		66.997%	
"Kaiser-Meyer-Olkin Measure of Sampling Adequacy"		0.855	
"Bartlett's Test of Sphericity"	X^2	12420.131	
	df	325	
	Significant	0.000	

Note: Extraction method: principal component analysis

Table 2 shows the factor loading values for 26 items used in the study. The items are grouped into six different

factors: The Effort, Cognitive, Interest, Stat_achiev, and SC1-SC6. KMO test [34] was performed at 0.855, which exceeds the minimum requirement of 0.7 indicating that the sample is adequate for conducting a factor analysis. The total variance explained is 66.997%, which means that the factors identified in the analysis account for a substantial portion of the total variance in the data. In addition, screen plot output indicating the data have fifth factors data as shown in Figure 2.

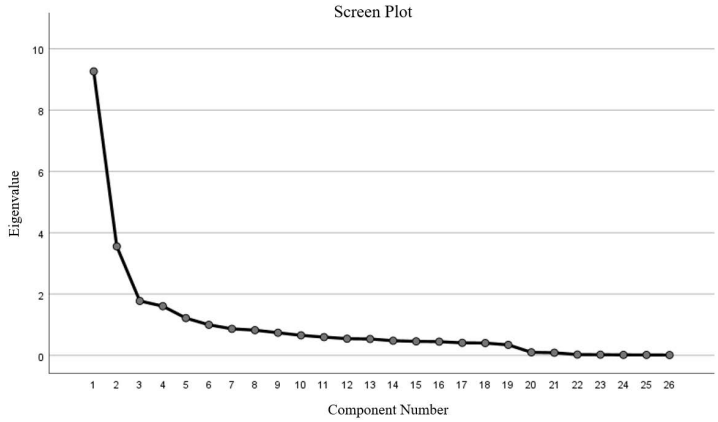

Figure 2. Screen plot output indicating that the data have fifth factors data

3.4 Reliability Analysis

Cronbach's alpha values indicate that the measurement scales used in the study are reliable and have good internal consistency, where Cronbach's alpha reliability coefficient is acceptable if exceeded 0.60 as shown in Table 3.

Table 3. Results Cronbach's α for each domain

Domain	Cronbach's α	N of Items
Effort	0.813	5
Cognitive-competence	0.927	6
Interest	0.889	4
Statistics achievement	0.759	5
Self-concept	0.858	6

The mean values for these variables are as follows: self-concept (3.486), effort (3.289), interest (3.205), statistical achievement (2.943), and cognitive competence (2.820). Causal modeling assumes that variables are normally distributed, which means that their skewness and kurtosis should not exceed an absolute value of 2 [12]. Table 4 shows that all variables in our study meet this standard, as the absolute values of their skewness and kurtosis fall within the desired range.

Table 4. Descriptive indices for each domain

Rank	Domain	Mean	Std. Deviation	Skewness	Kurtosis
1	Self-concept	3.486	0.691	-0.804	0.486
2	Effort	3.289	0.900	-0.375	-0.186
3	Interest	3.205	1.271	-0.220	-1.051
4	Statistics achievement	2.943	0.833	-0.217	-0.010
5	Cognitive-competence	2.820	1.114	0.045	-0.782

Effort and cognitive competence have a positive and significant correlation ($r = 0.529^{**}$, $p < 0.01$), indicating that there is a strong relationship between putting in effort and having higher cognitive competence. Similarly, effort and interest exhibit a positive and significant correlation ($r = 0.339^{**}$, $p < 0.01$), suggesting that there is a link between exerting effort and having a greater interest in the subject. Furthermore, cognitive competence and interest are positively and significantly correlated ($r = 0.264^{**}$, $p < 0.01$), indicating that higher cognitive competence is associated with a greater interest in the topic. The correlation between statistical achievement and effort is positive and significant ($r = 0.487^{**}$, $p < 0.01$), suggesting that there is a strong relationship between putting in more effort

and achieving better results in statistics. Similarly, statistical achievement and cognitive competence demonstrate a positive and significant correlation ($r = 0.428^{**}$, $p < 0.01$), indicating that higher cognitive competence is associated with better performance in statistics.

Additionally, statistical achievement and interest exhibit a positive and significant correlation ($r = 0.265^{**}$, $p < 0.01$), suggesting that a greater interest in the subject is associated with achieving better results in statistics. Lastly, self-concept shows positive and significant correlations with effort ($r = 0.585^{**}$, $p < 0.01$), cognitive competence ($r = 0.529^{**}$, $p < 0.01$), interest ($r = 0.414^{**}$, $p < 0.01$), and statistical achievement ($r = 0.417^{**}$, $p < 0.01$), indicating that a higher self-concept is associated with increased effort, cognitive competence, interest, and better performance in statistics, as shown in Table 5.

Table 5. Correlation matrix of the research variables

Variables	Effort	Cognitive Competence	Interest	Statistical Achievement	Self-Concept
Effort	1				
Cognitive competence	0.529^{**}	1			
Interest	0.339^{**}	0.264^{**}	1		
Statistical achievement	0.487^{**}	0.428^{**}	0.265^{**}	1	1
Self-concept	0.585^{**}	0.529^{**}	0.414^{**}	0.417^{**}	1

Note: * $p > 0.05$, ** $p > 0.01$

3.5 Confirmatory Factor Analysis (CFA)

The model fit was assessed before investigating the assumptions of the study. According to the study [13], Table 6 shows that the values for RMSEA, CFI, TLI, and IFI all exceed the recommended threshold values, indicating that the statistical model has a good fit. "The RMSEA value is 0.079, which is below the recommended threshold of 0.08, indicating a good fit. The CFI, TLI, and IFI values are all above the recommended threshold of 0.90, indicating a good fit. The value for χ^2/DF is 3.813, which is between the recommended threshold range of $1 \leq \chi^2/\mathrm{DF} < 5$", indicating a reasonable fit. The values presented in the table suggest that the statistical model has a good fit, with all fit indices falling within the recommended threshold ranges or exceeding them.

Table 6. Conformity fitness indices of model

CFI	TLI	IFI	RMSEA	χ^2/DF
0.935	0.926	0.935	0.079	3.813

Path analysis was employed to examine the hypotheses and investigate the relationships among effort, interest, cognitive competence, self-concept, and statistical achievement through the mediation of self-concept. Effort has a significant direct effect on statistical achievement (β = 0.355, $p < 0.01$), indicating that students who exert more effort are likely to perform better in statistics. Effort also has a significant indirect effect on statistical achievement through self-concept (β = 0.347, $p < 0.05$), indicating that self-concept partially mediates the relationship between effort and statistical achievement.

Similarly, interest shows a significant direct effect on statistical achievement (β = 0.317, $p < 0.01$), indicating that students with a greater interest in statistics are more likely to achieve better results. Interest also has a significant indirect effect on statistical achievement through self-concept (β = 0.493, $p < 0.05$), further supporting the idea that self-concept partially mediates the relationship between interest and statistical achievement.

Furthermore, cognitive competence demonstrates a significant direct effect on statistical achievement (β = 0.277, $p < 0.01$), indicating that students with higher cognitive competence are more likely to excel in statistics. Cognitive competence also has a significant indirect effect on statistical achievement through self-concept (β = 0.214, $p < 0.05$), suggesting that self-concept plays a partial mediating role in the relationship between cognitive competence and statistical achievement.

These findings highlight the importance of self-concept as a mediator in the relationships between effort, interest, cognitive competence, and statistical achievement. While effort, interest, and cognitive competence have direct effects on statistical achievement, self-concept serves as a partial mediator, indicating that it influences but does not fully account for the relationships between these variables and academic performance in statistics. Table 7 shows the path analysis impact of effort, interest, and cognitive competence on statistical achievement through meditation on self-concept statistics.

Table 7. Path analysis impact of effort, interest and cognitive competence on statistical achievement through meditation of self-concept statistics

Variables	Direct Effects	Indirect	Total Effects	Result
Effort	0.355^{**}	0.347^{**}	0.702^{**}	Partial mediation
Interest	0.317^{**}	0.493^{**}	0.810^{**}	Partial mediation
Cognitive competence	0.277^{**}	0.214^{**}	0.419^{**}	Partial mediation

Note: $p^{*} < 0.05; p^{***} < 0.01$

4 Discussion

The study shows that effort has a significant direct effect on statistical achievement is in line with the findings of the studies [14, 43], who also found a positive association between effort and achievement in statistics courses. The meta-analysis also supports the importance of effort as a predictor of academic achievement across different subjects, including mathematics [15]. The results of the study indicate that educators and policymakers should consider promoting and encouraging student effort in statistics education to improve their academic achievement in this subject. This can include strategies such as providing clear goals, feedback, and support for students to increase their dedication and persistence towards their academic pursuits.

The study's outcomes reinforce the notion that effort and academic achievement in statistics are positively correlated. The data indicates that effort has both a direct and indirect effect on statistical achievement, implying that students who put in more effort not only perform better but also have a higher self-concept concerning their abilities in this subject. The finding that self-concept mediates the relationship between effort and statistical achievement is also noteworthy. It suggests that students who view themselves positively in terms of their statistical abilities are more likely to put in higher levels of effort and subsequently score better grades in this subject. Our findings align with those of Stoeber and Stoeber [16], who observed a positive correlation between effort and academic performance in undergraduate students. Additionally, the study [15] supports our results by demonstrating a positive correlation between effort and academic achievement in various academic domains.

The study [54] is particularly relevant to our results, as it also found that self-concept partially mediated the relationship between effort and academic achievement. However, their study focused on middle school students, while our study focused on college students taking a statistics course. The results of this study have practical implications for educators and policymakers. For example, promoting a positive self-concept among students can be a useful strategy for increasing their motivation and effort towards academic pursuits, including statistics education. Educators can use a variety of techniques to enhance self-concept, such as providing positive feedback and support, using praise for effort, and helping students set realistic goals and expectations.

Previous research has indicated that interest plays a crucial role in academic achievement, including in the field of statistics. The studies [1, 15] have shown that interest is a significant predictor of academic performance in various subjects and can lead to greater engagement, attention, and understanding. This highlights the importance of making statistics more engaging and relevant to students' interests by using real-life examples, interactive activities, and meaningful applications.

Moreover, the finding that interest has an indirect effect on statistical achievement through self-concept underscores the significance of self-concept in academic success. Students who are interested in statistics may develop a more positive self-concept in the subject, which can enhance their motivation and performance. This is consistent with prior research that has demonstrated a positive relationship between interest, self-concept, and academic achievement [14, 44]. Therefore, educators and teachers should strive to cultivate students' interest and positive self-concept in statistics to improve their academic outcomes [15, 35]. These results indicate that efforts to improve students' self-concept in statistics may lead to greater interest and effort, which in turn may result in better academic performance.

Cognitive competence has a significant direct effect on statistical achievement, which is consistent with previous research. For example, Carter [38] found that cognitive competence was a significant predictor of achievement in mathematics among middle school students. Similarly, Xu and Schau [39] found that cognitive competence was a significant predictor of achievement in an undergraduate statistics course. In the context of statistics, students with higher cognitive competence may be better able to understand and apply statistical concepts, which can lead to better performance on exams and assignments. Additionally, they may be better able to engage in deep processing of the material, which can lead to better learning and retention of the concepts.

Self-concept partially mediates the relationship between cognitive competence and statistical achievement, which is an interesting result. It suggests that students with higher cognitive abilities may have a more positive self-concept related to their ability to learn and succeed in statistics, which in turn may contribute to their better performance.

The finding that self-concept serves as a partial mediator in the connection between cognitive competence and

statistical achievement holds important implications for policymakers and educators. It indicates that efforts to enhance students' cognitive abilities can also have a favorable influence on their self-concept and drive to excel in statistics. Furthermore, initiatives that focus on boosting students' self-concept and confidence in their skills can also play a significant role in improving their academic performance.

Social cognitive theory explains the positive association between cognitive competence and self-concept, proposing that an individual's self-efficacy beliefs are shaped by their past experiences and successes [44]. Therefore, students who possess higher cognitive competence are likely to excel in academic tasks, leading to a more favorable self-concept, which, in turn, fosters further success. The results of this research are consistent with previous studies that have also identified a positive correlation between cognitive competence and academic achievement [18, 54]. Moreover, self-concept has been identified as a crucial factor in academic performance [24], with students who have a positive self-concept being more motivated and displaying a more positive attitude towards their academic work [3]. The present study also reveals that self-concept partially mediates the connection between cognitive competence and statistical achievement, which aligns with prior research proposing that self-concept can serve as a mediator between cognitive competence and academic achievement [14, 25]. Overall, the findings suggest that students with higher cognitive competence may possess a more favorable self-concept, leading to better academic performance in statistics.

5 Conclusion

This study aimed to investigate the relationships among effort, interest, cognitive competence, and statistical achievement, mediated by self-concept, among undergraduate students at a Jordanian university. The results revealed that effort, interest, and cognitive competence had significant direct effects on statistical achievement. Additionally, self-concept partially mediated the relationships among effort, interest, cognitive competence, and statistical achievement. These findings suggest that both individual factors (effort, interest, and cognitive competence) and psychological factors (self-concept) play important roles in students' academic achievement in statistics.

The study's findings highlight the need for educators and policymakers to consider both individual and psychological factors when developing educational interventions to improve academic achievement in statistics. Efforts to enhance students' effort, interest, cognitive competence, and self-concept may lead to better academic outcomes. Specifically, educators should encourage students to exert more effort in their studies and foster their interest in statistics. Furthermore, educators should provide opportunities for students to develop and enhance their cognitive competence and self-concept by providing academic support, counseling services, and mentorship programs.

Recommendation

The findings suggest that educators and policymakers should consider promoting and encouraging student efforts in statistics education to improve their academic achievement in this subject. Strategies such as providing clear goals, feedback, and support for students to increase their dedication and persistence towards their academic pursuits can be effective.

Promoting a positive self-concept among students can also be a useful strategy for increasing their motivation and effort towards academic pursuits, including statistics education. Educators can use a variety of techniques to enhance self-concept, such as providing positive feedback and support, using praise for effort, and helping students set realistic goals and expectations.

Making statistics more engaging and relevant to students' interests by using real-life examples, interactive activities, and meaningful applications is another strategy that can help increase students' interest and, subsequently, their performance.

Limitations

The study used a sample size and self-reported measures. The sample size was limited to college students enrolled in a statistics course, which may not be representative of the entire population. Future studies could consider using a larger and more diverse sample to increase generalizability. Additionally, the use of self-report measures may have introduced biases, such as social desirability bias, where students may have reported higher levels of effort or interest than they actually put in. Future studies could consider using objective measures, such as attendance records or test scores, to assess effort and achievement.

Another limitation is that the study focused only on three factors, namely effort, interest, and self-concept, that may influence academic achievement in statistics. Other factors, such as prior knowledge, teaching methods, and motivation, may also be important predictors of academic achievement in this subject. Future studies could consider exploring the relationships between these additional factors and academic achievement in statistics.

Finally, the study used a cross-sectional design, which limits our ability to establish causality. While the results suggest that effort, interest, and self-concept may influence academic achievement in statistics, it is not clear whether these factors cause improvements in academic achievement or whether academic achievement leads to changes in

these factors. Future studies could consider using longitudinal designs to better establish the causal relationships between these factors and academic achievement in statistics.

Data Availability

Not applicable.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] M. Ainley, S. Hidi, and D. Berndorff, "Interest, learning, and the psychological processes that mediate their relationship," *J. Educ. Psychology*, vol. 94, no. 3, pp. 545–561, 2002. https://doi.org/10.1037/0022-0663.94.3.545

[2] U. Schiefele, A. Krapp, and A. Winteler, "Interest as a predictor of academic achievement: A meta-analysis of research," in *The Role of Interest in Learning and Development*. Psychology Press, UK, 2014, pp. 197–226. https://doi.org/10.4324/9781315807430-18

[3] B. J. Zimmerman and A. Kitsantas, "Homework practices and academic achievement: The mediating role of self-efficacy and perceived responsibility beliefs," *Contemp. Educ. Psychology*, vol. 30, no. 4, pp. 397–417, 2005. https://doi.org/10.1016/j.cedpsych.2005.05.003

[4] A. Wigfield and J. S. Eccles, "Expectancy–value theory of achievement motivation," *Contemp. Educ. Psychology*, vol. 25, no. 1, pp. 68–81, 2000. https://doi.org/10.1006/ceps.1999.1015

[5] H. W. Marsh, A. J. Martin, and K. T. Hau, "A multimethod perspective on self-concept research in educational psychology: A construct validity approach," in *Handbook of Multimethod Measurement in Psychology*. American Psychological Association, USA, 2006, pp. 441–456. https://doi.org/10.1037/11383-030

[6] M. Jaboob, M. Hazaimeh, and A. M. Al-Ansi, "Integration of generative AI techniques and applications in student behavior and cognitive achievement in Arab higher education," *Int. J. Human Comput. Interact.*, pp. 1–14, 2024. https://doi.org/10.1080/10447318.2023.2300016

[7] M. Jaboob, A. M. Salim Ba Awain, and A. M. Al-Ansi, "Sustaining employees' creativity through the organizational justice: The mediating role of leadership styles," *Social Sci. Hum. Open*, vol. 8, no. 1, p. 100693, 2023. https://doi.org/10.1016/j.ssaho.2023.100693

[8] A. M. Al-Ansi, M. Hazaimeh, A. Hendi, J. AL-hrinat, G. Adwan, and A. Garad, "Innovative responses to exogenous shocks in Indonesian transportation firms: Mediating role of sustainable performance and outcomes," *Int. J. Sustainable Dev. Plann.*, vol. 18, no. 9, pp. 2663–2672, 2023. https://doi.org/10.18280/ijsdp.180905

[9] A. M. S. Ba Awain, A. M. Al-Ansi, and M. Jaboob, "Green supply chain management: A comprehensive review of research, applications and future directions," *Manage. Prod. Eng. Rev.*, 2023. https://doi.org/10.24425/mper.2023.147194

[10] M. Hazaimeh and M. Alquraan, "The effectiveness of the number of extra negative items in detecting insufficient effort responses in non-cognitive scales," *J. Appl. Math. Phys.*, vol. 10, no. 10, pp. 3191–3207, 2022. https://doi.org/10.4236/jamp.2022.1010212

[11] Y. D. Arthur, C. S. K. Dogbe, and S. K. Asiedu-Addo, "Modeling students' mathematics achievement and performance through teaching quality: Servqual perspective," *J. Appl. Res. Higher Educ.*, vol. 14, no. 4, pp. 1509–1523, 2021. https://doi.org/10.1108/jarhe-06-2021-0243

[12] M. S. Bartlett, "A note on the multiplying factors for various χ^2 approximations," *J. R. Stat. Soc. Ser. B*, vol. 16, no. 2, pp. 296–298, 1954. https://doi.org/10.1111/j.2517-6161.1954.tb00174.x

[13] A. M. Al-Ansi, M. Jaboob, and A. M. S. B. Awain, "Examining the mediating role of job satisfaction between motivation, organizational culture, and employee performance in higher education: A case study in the Arab region," *Educ. Sci. Manage.*, vol. 1, no. 1, pp. 30–42, 2023. https://doi.org/10.56578/esm010104

[14] B. N. Githua and R. A. Nyabwa, "Effects of advance organiser strategy during instruction on secondary school students' mathematics achievement in Kenya's Nakuru district," *Int. J. Sci. Math. Educ.*, vol. 6, no. 3, pp. 439–457, 2007. https://doi.org/10.1007/s10763-006-9037-8

[15] S. Hidi and K. A. Renninger, "The four-phase model of interest development," *Educ. Psychologist*, vol. 41, no. 2, pp. 111–127, 2006. https://doi.org/10.1207/s15326985ep4102_4

[16] J. Stoeber and F. S. Stoeber, "Domains of perfectionism: Prevalence and relationships with perfectionism, gender, age, and satisfaction with life," *Pers. Individual Differences*, vol. 46, no. 4, pp. 530–535, 2009. https://doi.org/10.1016/j.paid.2008.12.006

[17] R. Buchanan and M. Csikszentmihalyi, "Flow: The psychology of optimal experience," *Des. Issues*, vol. 8, no. 1, p. 80, 1991. https://doi.org/10.2307/1511458

[18] E. L. Deci and R. M. Ryan, "The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior," *Psychological Inquiry*, vol. 11, no. 4, pp. 227–268, 2000. https://doi.org/10.1207/s15327965pli1104_01

[19] A. L. Duckworth, C. Peterson, M. D. Matthews, and D. R. Kelly, "Grit: Perseverance and passion for long-term goals," *J. Pers. Soc. Psychology*, vol. 92, no. 6, pp. 1087–1101, 2007. https://doi.org/10.1037/0022-3514.92.6.1087

[20] A. Mrdak and T. Nanuševski, "Evaluating the employment efficiency of IT candidates using data envelopment analysis," *Acadlore Trans. Appl. Math. Stat.*, vol. 1, no. 1, pp. 10–21, 2023. https://doi.org/10.56578/atams010102

[21] A. M. Al-Ansi, M. Hazaimeh, A. Hendi, J. AL-hrinat, and G. Adwan, "How do social media influencers change adolescents' behavior? An evidence from Middle East countries," *Heliyon*, vol. 9, no. 5, p. e15983, 2023. https://doi.org/10.1016/j.heliyon.2023.e15983

[22] A. M. Al-Ansi and A. Al-Ansi, "Enhancing student-centered learning through introducing module for STEM development and assessment," *Int. J. STEM Educ. Sustainability*, vol. 3, no. 1, pp. 22–27, 2023. https://doi.org/10.53889/ijses.v3i1.114

[23] M. T. Wang and J. S. Eccles, "School context, achievement motivation, and academic engagement: A longitudinal study of school engagement using a multidimensional perspective," *Learn. Instruction*, vol. 28, pp. 12–23, 2013. https://doi.org/10.1016/j.learninstruc.2013.04.002

[24] C. K. Stevens and M. E. Gist, "Effects of selfefficacy and goalorientation training on negotiation skill maintenance: What are the mechanisms?" *Pers. Psychology*, vol. 50, no. 4, pp. 955–978, 1997. https://doi.org/10.1111/j.1744-6570.1997.tb01490.x

[25] R. W. Butler, "An intelligent treatise on human intelligence," *J. Int. Neuropsychol Soc.*, vol. 7, no. 3, pp. 401–401, 2001. https://doi.org/10.1017/s1355617701253144

[26] H. W. Marsh, "A multidimensional, hierarchical model of self-concept: Theoretical and empirical justification," *Educ. Psychology Rev.*, vol. 2, no. 2, pp. 77–172, 1990. https://doi.org/10.1007/bf01322177

[27] H. W. Marsh, A. S. Abduljabbar, P. D. Parker, A. J. S. Morin, F. Abdelfattah, B. Nagengast, J. Möller, and M. M. Abu-Hilal, "The internal/external frame of reference model of self-concept and achievement relations," *Am. Educ. Res. J.*, vol. 52, no. 1, pp. 168–202, 2015. https://doi.org/10.3102/0002831214549453

[28] R. Hassad, "Teaching introductory statistics for evidence-based practice: Integration of context," in *Proceedings of the Joint IASE/IAOS Satellite Conference, Macao, China*, 2013. https://doi.org/10.52041/srap.13101

[29] J. F. Hair, R. E. Anderson, B. J. Babin, and W. C. Black, *Multivariate Data Analysis: A Global Perspective*. Upper Saddle River, Pearson, NJ, USA, 2010.

[30] A. M. Al-Ansi and A. Al-Ansi, "An overview of artificial intelligence (AI) in 6G: Types, advantages, challenges and recent applications," *Buletin Ilmiah Sarjana Teknik Elektro*, vol. 5, no. 1, 2023. https://doi.org/10.12928/biste.v5i1.7603

[31] T. Honicke and J. Broadbent, "The influence of academic self-efficacy on academic performance: A systematic review," *Educ. Res. Rev.*, vol. 17, pp. 63–84, 2016. https://doi.org/10.1016/j.edurev.2015.11.002

[32] M. Lee and I. Erdogan, "The effect of science–technology–society teaching on students' attitudes toward science and certain aspects of creativity," *Int. J. Sci. Edu.*, vol. 29, no. 11, pp. 1315–1327, 2007. https://doi.org/10.1080/09500690600972974

[33] D. H. Schunk, "Self-efficacy and academic motivation," *Educ. Psychologist*, vol. 26, no. 3-4, pp. 207–231, 1991. https://doi.org/10.1080/00461520.1991.9653133

[34] U. Sekaran and R. Bougie, "Research methods for business: A skill building approach," *Leadersh. Organiz. Dev. J.*, vol. 34, no. 7, pp. 700–701, 2013. https://doi.org/10.1108/lodj-06-2013-0079

[35] A. Al-Ansi, "Implementation of ICT at university level during Covid-19 pandemic: An evidence from Yemen," *Asia-Pac. J. Educ. Manage. Res.*, vol. 6, no. 1, pp. 37–54, 2021. https://doi.org/10.21742/ajemr.2021.6.1.04

[36] N. R. Kuncel and S. A. Hezlett, "Standardized tests predict graduate students' success," *Science*, vol. 315, no. 5815, pp. 1080–1081, 2007. https://doi.org/10.1126/science.1136618

[37] S. Lloret, A. Ferreres, A. Hernández, and I. Tomás, "El análisis factorial exploratorio de los ítems: Análisis guiado según los datos empíricos y el software," *Anales de Psicología*, vol. 33, no. 2, p. 417, 2017. https://doi.org/10.6018/analesps.33.2.270211

[38] M. Carter, "Visible learning: A synthesis of over 800 metaanalyses relating to achievement," *Educ. Psychology*, vol. 29, no. 7, pp. 867–869, 2009. https://doi.org/10.1080/01443410903415150

[39] C. Xu and C. Schau, "Exploring method effects in the six-factor structure of the survey of attitudes toward statistics (SATS-36)," *Stat. Educ. Res. J.*, vol. 18, no. 2, pp. 39–53, 2019.

[40] J. Sweller, "Cognitive load theory, learning difficulty, and instructional design," *Learn. Instruction*, vol. 4,

no. 4, pp. 295–312, 1994. https://doi.org/10.1016/0959-4752(94)90003-5

[41] J. Sweller, P. Ayres, and S. Kalyuga, "Measuring cognitive load," in *Cognitive Load Theory*. Springer New York, USA, 2011, pp. 71–85. https://doi.org/10.1007/978-1-4419-8126-4_6

[42] M. Wang and J. S. Eccles, "Adolescent behavioral, emotional, and cognitive engagement trajectories in school and their differential relations to educational success," *J. Res. Adolescence*, vol. 22, no. 1, pp. 31–39, 2011. https://doi.org/10.1111/j.1532-7795.2011.00753.x

[43] L. Zhang and R. J. Sternberg, "A threefold model of intellectual styles," *Educ. Psychology Rev.*, vol. 17, no. 1, pp. 1–53, 2005. https://doi.org/10.1007/s10648-005-1635-4

[44] H. W. Marsh and R. G. Craven, "Reciprocal effects of self-concept and performance from a multidimensional perspective: Beyond seductive pleasure and unidimensional perspectives," *Perspect. Psychological Sci.*, vol. 1, no. 2, pp. 133–163, 2006. https://doi.org/10.1111/j.1745-6916.2006.00010.x

[45] K. J. Preacher and A. F. Hayes, "Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models," *Behav. Res. Methods*, vol. 40, no. 3, pp. 879–891, 2008. https://doi.org/10.3758/brm.40.3.879

[46] S. Haroon, M. Abuzar, and M. F. Khan, "Analyzing sensitivity and solitonic behavior using the Dullin–Gottwald–Holm model in shallow water waves," *Acadlore Trans. Appl. Math. Stat.*, vol. 1, no. 2, pp. 96–110, 2023. https://doi.org/10.56578/atams010205

[47] A. M. Al-Ansi, A. Garad, and V. Ryabtsev, "Intelligent risk analysis of investment projects in the extractive industry," *J. Ind. Intell.*, vol. 2, no. 1, pp. 42–53, 2024. https://doi.org/10.56578/jii020104

[48] M. K. Hartwig and J. Dunlosky, "Study strategies of college students: Are self-testing and scheduling related to achievement?" *Psychonomic Bull. Rev.*, vol. 19, no. 1, pp. 126–134, 2011. https://doi.org/10.3758/s13423-011-0181-y

[49] K. R. Wentzel, "Are effective teachers like good parents? Teaching styles and student adjustment in early adolescence," *Child Dev.*, vol. 73, no. 1, pp. 287–301, 2002. https://doi.org/10.1111/1467-8624.00406

[50] J. Wang, X. Huang, and X. Wang, "Risk spillovers and hedging in the Chinese stock market: An asymmetric VAR-BEKK-AGARCH analysis," *Acadlore Trans. Appl. Math. Stat.*, vol. 1, no. 3, pp. 111–129, 2023. https://doi.org/10.56578/atams010301

[51] A. Al-Ansi, A. M. Al-Ansi, A. Muthanna, and A. Koucheryavy, "Blockchain technology integration in service migration to 6g communication networks: A comprehensive review," *Indonesian J. Electr. Eng. Comput. Sci.*, vol. 34, no. 3, pp. 1654–1664, 2024. https://doi.org/10.11591/ijeecs.v34.i3.pp1654-1664

[52] S. G. West, A. B. Taylor, and W. Wu, "Model fit and model selection in structural equation modeling," in *Handbook of Structural Equation Modeling*. The Guilford Press, USA, 2012, pp. 209–231.

[53] K. A. Renninger and S. Hidi, "Revisiting the conceptualization, measurement, and generation of interest," *Educ. Psychologist*, vol. 46, no. 3, pp. 168–184, 2011. https://doi.org/10.1080/00461520.2011.587723

[54] E. A. Linnenbrink and P. R. Pintrich, "Achievement goal theory and affect: An asymmetrical bidirectional model," *Educ. Psychologist*, vol. 37, no. 2, pp. 69–78, 2002. https://doi.org/10.1207/s15326985ep3702_2

[55] A. Hendi, J. Al-Hrinat, A. M. Al-Ansi, and M. Hazaimeh, "Strategies for optimizing medical waste management and treatment technologies in Jordanian hospitals," *Oppor. Chall. Sustain.*, vol. 3, no. 1, pp. 35–49, 2024. https://doi.org/10.56578/ocs030103

[56] U. Sproesser, J. Engel, and S. Kuntze, "Fostering self-concept and interest for statistics through specific learning environments," *Stat. Educ. Res. J.*, vol. 15, no. 1, pp. 28–54, 2016. https://doi.org/10.52041/serj.v15i1.256

[57] A. Alameri, A. Mahboob, and E. T. Karash, "Neighborhood degree-based graph descriptors: A comprehensive analysis of connectivity patterns in diverse graph families and their applicapability," *Acadlore Trans. Appl. Math. Stat.*, vol. 2, no. 1, pp. 52–63, 2024. https://doi.org/10.56578/atams020105