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Relationship between Self-directed Learning and Problem-solving with the Mediate Role of Academic Self-efficacy and Moderating Gender in Students

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A B S T R A C T

Purpose: This study aimed to investigate the relationship between self-directed learning and problem-solving skills among university students, considering the mediating role of academic self-efficacy and the moderating effect of gender.
Methods and Materials: The research employed a descriptive-correlational design and structural equation modeling (SEM). The study population included all students at Al-Qadisiyah University in Iraq during the 2023–2024 academic year. A sample of 300 students was selected through convenience sampling. Data were collected using three standardized instruments: the Problem-Solving Styles Questionnaire (Cassidy & Long, 1996), the Self-Directed Learning Questionnaire (Cheng et al., 2010), and the Academic Self-Efficacy Questionnaire (Owen & Froman, 1988). Pearson correlation coefficients and SEM with SmartPLS software were applied for statistical analysis. Reliability and validity indices confirmed the appropriateness of the instruments and measurement models.
Findings: Results demonstrated significant positive correlations between self-directed learning, academic self-efficacy, and problem-solving skills. Path analysis indicated that self-directed learning directly influenced problem-solving ($\beta = 0.213$, $p < 0.01$) and academic self-efficacy ($\beta = 0.515$, $p < 0.01$). Academic self-efficacy, in turn, significantly predicted problem-solving ability ($\beta = 0.488$, $p < 0.01$). Furthermore, academic self-efficacy partially mediated the relationship between self-directed learning and problem-solving (indirect effect $\beta = 0.252$, $p < 0.01$). Gender also moderated the relationship, as indicated by significant differences in problem-solving performance between male and female students ($\beta = 0.132$, $p < 0.01$). The model showed satisfactory fit indices, with R^2 values indicating that 26.26% of the variance in academic self-efficacy and 37.5% of the variance in problem-solving were explained by the predictors.
Conclusion: The findings highlight that enhancing students' self-directed learning abilities strengthens academic self-efficacy, which in turn improves problem-solving skills. Gender differences further shape these relationships, underscoring the need for tailored educational strategies.
Keywords: *Self-directed learning; Problem-solving; Academic self-efficacy; Gender; Higher education*

1. Introduction

Enhancing students' skills one of which is problem-solving ability is a core objective of higher education learning. Problem solving is considered a fundamental necessity for individual adaptation and social well-being (Jakhar, 2019). In their personal and social lives, all individuals face various issues, including personal, daily, academic, occupational, social, and relational problems involving friends, family, the community, the workplace, and other settings. Scholars argue that problem-solving represents the highest level of human cognitive activity, and to address these issues effectively, individuals require specific coping skills. These skills encompass a range of competencies and personal attributes (Du, 2013; Hassani Ahmadieh & Nouri, 2022). Acquired problem-solving skills contribute to achieving academic goals and attaining higher grade point averages. Moreover, these skills not only support students in their academic careers but also empower them to handle future life challenges successfully (Almulla & Al-Rahmi, 2023).

The problem-solving process involves reflective judgment, which monitors implementation and outcomes and modifies strategies/actions when necessary (Hendricson et al., 2006). Implementing such reflective judgment requires self-directed learning capacity (Canniford & Fox-Young, 2015; Hendricson et al., 2006). Self-directed learning skills can enhance confidence, independence, motivation, problem-solving ability, creativity, and lifelong learning competencies (Lunyk-Child et al., 2001; Qian et al., 2023; Song et al., 2022; Taylor & Hamdy, 2013). This type of learning turns the learner into an active participant in the learning process and encourages them to function as deep learners (Tekkol & Demirel, 2018). Within this approach, the learner actively defines their learning needs and objectives, seeks out necessary resources, applies appropriate strategies, and evaluates their learning outcomes. In short, by emphasizing personal responsibility in learning, this approach enables individuals to participate actively and consciously in their educational journey (Collier, 2023).

This model—relying on a set of cognitive and metacognitive strategies—can reduce academic self-handicapping and promote self-directed learning among students (Soleymani et al., 2021). As a fundamental competence, self-directed learning helps adults adapt to complex social changes and prepares them for successful living and working in the modern world. More research in formal educational settings is necessary to cultivate this competence, ensuring that learners can adapt to today's complex and dynamic world (Morris, 2019).

Previous studies have shown that self-directed learning can significantly impact problem-solving. For instance, the study by Tafarroji Gilavandani et al. (2021) revealed that self-regulated learning strategies influenced students' approaches to problem-solving (Tafaroji Gilavandani et al., 2021). Similarly, studies by Hwang & Oh (2021) and Leary et al. (2019) confirmed a correlation between self-directed learning and problem-solving skills (Hwang & Oh, 2021).

On the other hand, research has shown that self-directed learning can significantly influence academic self-efficacy. In this regard, the study by Hamed et al. (2023) demonstrated a significant relationship between learning strategies and academic self-efficacy, with self-efficacy acting as a mediating factor between learning strategies and academic performance among science students in Iraq (Hamed et al., 2023). Likewise, Ranjbar et al. (2019) found that self-directed learning contributes to enhancing students' academic self-efficacy (Ranjbar et al., 2019).

Moreover, students with higher levels of perceived self-efficacy tend to exhibit more curiosity, exploration, and a willingness to engage in problem-solving activities (as cited in (Karakurt & Şeker, 2020). In fact, self-efficacy is a powerful factor that shapes how individuals behave, think, and react when confronted with unpleasant or challenging situations (Alavi et al., 2017; Downes et al., 2017). Research further suggests that self-efficacy contributes to reducing fear of failure, raising aspirations, and enhancing problem-solving skills and analytical thinking abilities (Nguyen et al., 2024).

Given that self-efficacy plays a critical role in controlling the learning process, a higher level of self-efficacy can lead to greater problem-solving capacity (Kokcu & Cevik, 2020). Prior studies also indicate a statistically significant and positive relationship between students' academic self-efficacy and their problem-solving skills (Alersan, 2017; Karakurt & Şeker, 2020).

Furthermore, earlier research has shown that academic self-efficacy can function as a mediating variable between various psychological, cognitive, emotional, and educational factors, including learning and problem-solving abilities (Hamed et al., 2023; Khamoushian Sahneh et al., 2023; Nemati et al., 2023; Yi et al., 2024; Zekeriya et al., 2019; Zhou et al., 2019).

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Academic self-efficacy refers to an individual's belief in their ability to succeed in academic tasks, achieve classroom goals, complete assignments satisfactorily, earn acceptable grades, and persist in their chosen field of study (Chakkaravarthy et al., 2020). It represents the learner's sense of empowerment in managing learning activities and creating conditions conducive to mastering academic subjects and fulfilling personal academic expectations (Muris, 2001). Academic self-efficacy positively influences effort, persistence, and coping with challenging situations, ultimately resulting in improved academic performance (Shen, 2018).

Individuals with high academic self-efficacy beliefs perceive difficult tasks as stimulating challenges, remain committed to their goals, intensify their efforts following setbacks, and ultimately their perseverance leads to success (Zander et al., 2018). Conversely, difficult tasks are perceived as personal threats by those with low academic self-efficacy (Jung et al., 2017). This is because highly self-efficacious individuals tend to use higher-level cognitive processes such as analysis, synthesis, and evaluation when solving complex problems, while those with low self-efficacy rely on lower-level cognitive processes and tend to doubt their ability to succeed (Bandura et al., 2001).

Research has also shown that there is a significant difference between gender and problem-solving abilities. Gender appears to influence certain sub-dimensions of problem-solving skill scales, academic self-efficacy, and learning processes (Jakhar, 2019; Karakurt & Şeker, 2020; Voyer & Voyer, 2014). For instance, Alersan (2017) found a statistically significant gender difference in academic self-efficacy in favor of female students (Alersan, 2017). Similarly, Karakurt and Şeker (2020) reported that gender impacts specific sub-dimensions of problem-solving skills and academic self-efficacy scales (Karakurt & Şeker, 2020).

In recent decades, Iraq's higher education system has experienced progressive deterioration, primarily due to budget deficits resulting from two consecutive wars, United Nations sanctions, political unrest, and the implementation of unsystematic educational policies. Since 2003, similar to other sectors in Iraq, higher education has been heavily affected by widespread violence across most provinces (Al-Azawei et al., 2016).

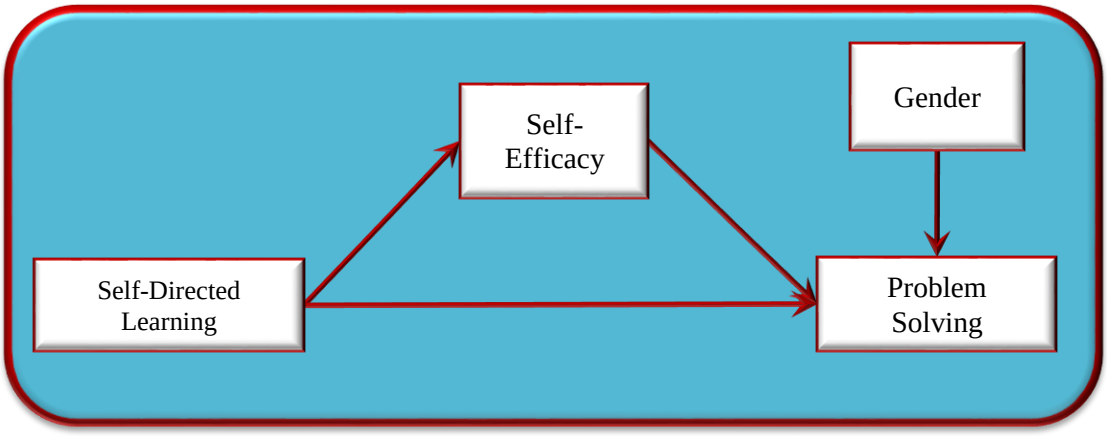
Given the results of previous research on the relationship between the variables in this study—and considering the significant influence these variables have on students' academic performance, educational progress, and future success—as well as the fact that no previous study in Iraq has addressed this specific topic, the present research seeks to address the following central question:

What is the effect of self-directed learning on problem-solving skills, and what is the mediating role of academic self-efficacy and the moderating role of gender in this relationship?

The conceptual model of this research is presented in *Figure 1*, which posits a direct effect of self-directed learning on problem-solving ability. Furthermore, it is hypothesized that academic self-efficacy plays a mediating role in the relationship between self-directed learning and problem-solving, while gender functions as a moderating variable.

Figure 1

The structural relationship between self-directed learning and students' problem-solving ability, with the mediating role of academic self-efficacy and the moderating effect of gender.



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2. Methods and Materials

2.1. Study Design and Participants

This study employed a descriptive-correlational research design, which falls within the category of descriptive studies and was conducted using the structural equation modeling (SEM) approach. The research investigated the relationship between one predictor variable and one criterion variable, with the mediation of two variables and the moderating role of one variable.

The statistical population of this study consisted of all students at Al-Qadisiyah University in Iraq during the academic year 2023–2024. Given that the methodological approach of structural equation modeling closely resembles some aspects of multivariate regression analysis, it is appropriate to apply similar principles in determining sample size for SEM (Hooman, 2005). According to Giles (2013), an acceptable sample size for correlational studies is approximately 15 to 20 participants per correlational relationship (Giles, 2013).

Therefore, based on the number of correlational relationships and predictor variables in this study, a sample size of 240 participants was considered sufficient. However, accounting for potential attrition, a total of 300 students were selected through convenience sampling from the target population and completed the research questionnaires.

2.2. Measures

The Problem-Solving Styles Questionnaire developed by Cassidy and Long (1996), consists of 24 items and includes six subscales: *Helplessness*, *Control*, *Creativity*, *Confidence*, *Approach*, and *Avoidance (*Cassidy & Long, 1996*)*. The questionnaire is scored on a three-point Likert scale ("Yes", "I don't know", "No"). Items 1 to 4 assess *Helplessness*, items 5 to 8 assess *Control*, items 9 to 12 assess *Creativity*, items 13 to 16 assess *Confidence*, items 17 to 20 assess *Avoidance*, and items 21 to 24 assess *Approach*.

Scoring is binary: responses are coded as 0 or 1, with the "I don't know" option assigned a score of 0.5. Accordingly, each subscale has a minimum score of 0 and a maximum of 4. A higher score in any given subscale indicates that the respondent tends to use that particular strategy when facing problems. Thus, the total problem-solving score ranges from 0 to 24.

In terms of reliability, the original developers reported Cronbach's alpha coefficients for the subscales as follows: Helplessness (0.66), Control (0.66), Creativity (0.57), Confidence (0.71), Avoidance (0.52), and Approach (0.65).

In another study, these coefficients were reported as: 0.86, 0.60, 0.66, 0.66, 0.51, and 0.53, respectively. The internal consistency coefficients for the subscales (Helplessness, Control, Avoidance, Confidence, Approach, and Creativity) were also reported to be 0.86, 0.66, 0.71, 0.52, and 0.65, respectively (Cassidy & Burnside, 1996).

In a psychometric evaluation by Babapour Khiraldin et al. (2003), the Cronbach's alpha for the overall questionnaire was found to be 0.77, and the validity coefficient was 0.87 (Babapour Kheyraldim et al., 2003). When considering the reliability coefficient as an indicator of construct validity (calculated as the square root of the reliability coefficient), the validity of the scale was also reported as 0.87.

In the present study, the Cronbach's alpha coefficient calculated for this questionnaire was 0.791, indicating good internal consistency.

The Self-Directed Learning Questionnaire, developed by Cheng et al. (2010), was designed to measure self-directed learning among students (Cheng et al., 2010). This questionnaire consists of 20 items, each answered on a five-point Likert scale ranging from strongly agree (5) to strongly disagree (1). It includes four dimensions: *Learning Motivation*, *Planning and Implementation*, *Self-Monitoring*, and *Interpersonal Communication*.

- Items 1 to 6 assess the *Learning Motivation* dimension,
- Items 7 to 12 assess *Planning and Implementation*,
- Items 13 to 16 assess *Self-Monitoring*,
- Items 17 to 20 assess *Interpersonal Communication*.

The minimum possible total score on this questionnaire is 20, and the maximum is 100. Due to differences in the number of items per dimension, the mean scores in each dimension range between 1 and 5.

The developers reported the overall reliability of the instrument using Cronbach's alpha coefficient as 0.916 for the entire questionnaire and 0.801, 0.816, 0.785, and 0.765 for the four respective dimensions. Furthermore, Taj et al. (2019) examined the validity and reliability of the questionnaire and confirmed its construct validity. Their research findings indicated a significant positive correlation between this construct and mastery goals, performance-approach goals, and all components of emotional intelligence, while a significant negative correlation was observed with avoidance-approach goals.

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Reliability of the scale, based on Cronbach's alpha, was reported as 0.91 for the total scale, and 0.81, 0.82, 0.75, and 0.75 for each subscale, demonstrating the instrument's high reliability. In the present study, Cronbach's alpha coefficient for this questionnaire was calculated as 0.786.

Academic Self-Efficacy Questionnaire for Students: The Academic Self-Efficacy Questionnaire, developed by Owen & Froman (1988), was created to measure students' beliefs regarding their academic self-efficacy. Owen and Froman consulted seven educational experts during the development of this questionnaire. The original instrument contains 33 items, scored on a five-point Likert scale ranging from *very low* to *very high*, and measures students' confidence related to note-taking, asking questions, paying attention in class, computer use, and more. Since item 28 pertains to laboratory work and not all academic disciplines include laboratory courses, this item was removed in the Persian version, reducing the total number of items to 32. The minimum possible total score is 32, and the maximum is 160, with higher scores indicating higher academic self-efficacy (Asghari et al., 2014). The developers reported a test-retest reliability coefficient of 0.90 over an eight-week interval. In Iran, internal consistency for the entire test was found to be 0.91, with Cronbach's alpha values of 0.91 for female students and 0.90 for male students, indicating good internal reliability.

The validity of this questionnaire has been confirmed through exploratory and confirmatory factor analyses, with reliability coefficients exceeding 0.70 based on Cronbach's alpha (Jamali et al., 2012). Additionally, the internal consistency of this instrument was confirmed by Asghari et al. (2014) in a pilot study with 35 students, reporting Cronbach's alpha of 0.93, and in a larger study with 343 students from Kharazmi University, with an alpha of 0.91 (Asghari et al., 2014).

In the present study, the Cronbach's alpha coefficient for this questionnaire was 0.88.

2.3. Data Analysis

At the conclusion of data collection, the information was analyzed using Pearson correlation coefficients and structural equation modeling (SEM) via SPSS version 26 and PLS version 3.2.8. It is important to note that all participants provided informed consent and willingly participated in the study.

3. Findings and Results

The descriptive results of the study showed that 54% of the research sample were male, and the remaining 46% were female. Therefore, it can be stated that a higher percentage of the sample consisted of males.

Regarding age distribution, 71% of the sample were 24 years old or younger, 22.3% were between 25 and 30 years old, and 6.7% were older than 30 years. Hence, it can be concluded that the majority of the sample were aged 24 years or younger.

In terms of educational level, 5% of the sample were enrolled in an Associate degree, 57% in a Bachelor's degree, and 38% in a Master's degree or higher. Thus, it can be stated that the largest proportion of the sample were undergraduate students.

Table 1

Means, Standard Deviations, and Correlations Among Research Variables

Research Variables	Mean	Standard Deviation	1	2	3
Self-Directed Learning	85.96	8.55	1		
Academic Self-Efficacy	133.97	22.07	**0.678	1	
Problem Solving	15.75	1.99	**0.501	**0.543	1

**p < 0.01

Table 1 presents the means, standard deviations of the research variables, and the correlations among them. The results of the Pearson correlation coefficient indicate that there is a significant positive relationship between self-directed learning and problem-solving (r = 0.501), and between self-directed learning and academic self-efficacy (r = 0.678) (p < 0.01).

To test the validity of the theoretical model and calculate the path coefficients, the Structural Equation Modeling (SEM) method was employed using the Smart PLS software. The significance of path coefficients and factor loadings was assessed by conducting the bootstrapping procedure.

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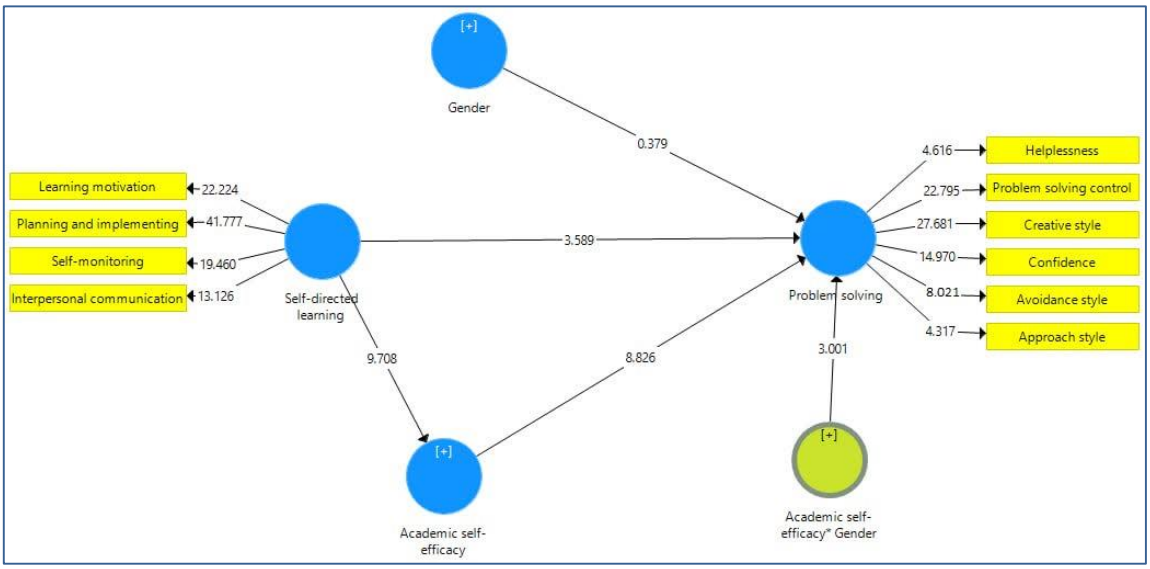
Figure 2

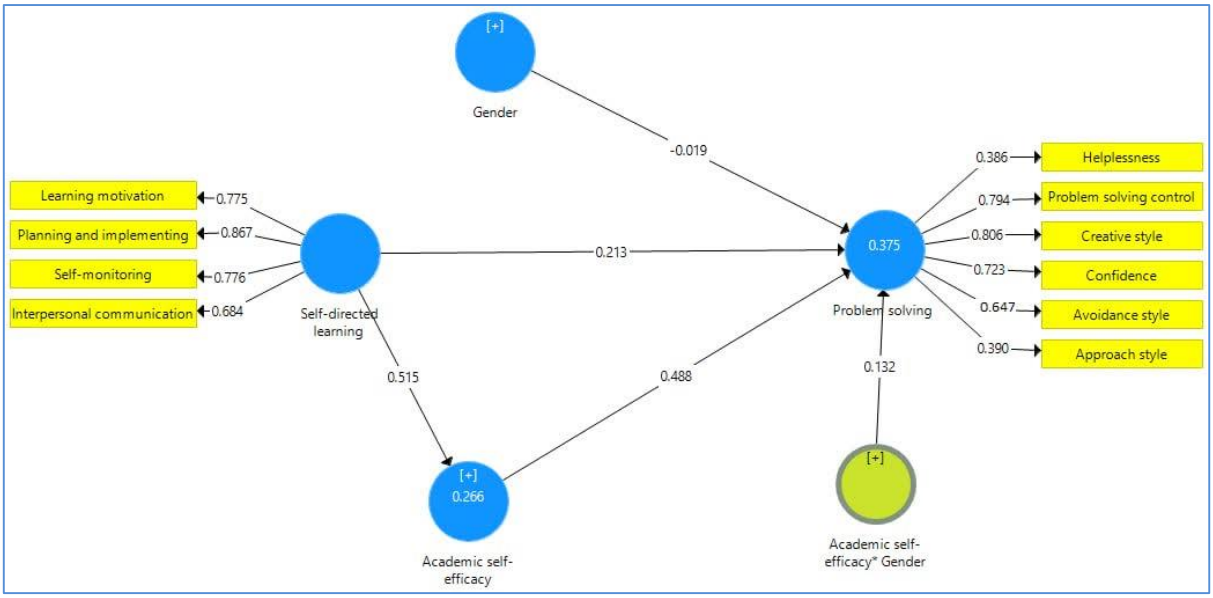
Tested model of research variables based on t-values



As shown in Figure 2, the t-values for all paths are greater than 1.96 ($p < 0.05$), indicating significant relationships among the research variables. The calculated t-values between self-directed learning and problem-solving was 3.589, between self-directed learning and academic self-efficacy was 9.708, and between academic self-efficacy and problem-solving was 8.826, all of which confirm statistically significant relationships among the variables studied.

Figure 3

Tested Model of Research Variables Based on Path Coefficients



In Figure 3, the path coefficients representing the strength of the relationships are shown. The magnitude of each path coefficient indicates the intensity and strength of the relationship between two variables. Based on the path coefficients, it can be stated that self-directed learning has an effect on academic self-efficacy with a path coefficient of 0.515. Additionally, self-directed learning influences problem-solving with a path coefficient of 0.213.

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It is noteworthy that the numbers inside the circles for the endogenous variables represent the R^2 values. The coefficient of determination (R^2) indicates the proportion of the variance in the dependent variable explained by the independent variables. According to the R^2 values in Figure 3, approximately 26.26% of the variance in perceived academic self-efficacy is explained by self-directed learning, and 37.5% of the variance in problem-solving is explained by self-directed learning, academic self-efficacy, and gender.

Table 2

A summary of the Structural Equation Modeling results

Variables	Path Coefficient (β)	Squared Path Coefficient	t-Statistic	Significance (p)
Self-Directed Learning → Problem Solving	0.213	0.045	3.556	0.001
Self-Directed Learning → Academic Self-Efficacy	0.515	0.268	9.936	0.001
Academic Self-Efficacy → Problem Solving	0.488	0.238	8.101	0.001
Self-Directed Learning → Academic Self-Efficacy → Problem Solving (Indirect Effect)	0.252		6.083	0.001
Academic Self-Efficacy × Gender → Problem Solving (Moderation Effect)	0.132		2.902	0.004

The findings in Table 2 indicate that the relationship between self-directed learning and problem-solving (β = 0.213, t = 3.556) and between self-directed learning and academic self-efficacy (β = 0.515, t = 9.936), as well as between academic self-efficacy and problem-solving (β = 0.488, t = 8.101), are positive and statistically significant. Based on these results, the relationships between the research variables are confirmed. Additionally, the indirect effect of self-directed learning on perceived problem-solving through the mediating role of academic self-efficacy (β = 0.252, t = 6.083) is also significant. Considering the significant direct effect, the mediating role of academic self-efficacy in the relationship between self-directed learning and problem-solving is partial. The moderating role of gender on problem-solving (β = 0.132, t = 2.902) indicates that there is a difference in problem-solving between the two genders.

In the evaluation of the model using Structural Equation Modeling (SEM), the first factor to consider is the unidimensionality of the model indicators. This means that each indicator should load strongly on only one latent variable, with a factor loading greater than 0.6. It is important to note that factor loadings less than 0.3 are considered small and such indicators should be removed from the set of indicators. This is typically done manually by eliminating indicators with factor loadings less than 0.4. In this model, the calculated factor loadings for all items exceeded the threshold of 0.3.

Table 3

Reliability and Validity Indices of Measurement Models and Structural Model Evaluation

Variable	Composite Reliability	Convergent Validity	Discriminant Validity
Self-Directed Learning	0.859	0.606	0.778
Academic Self-Efficacy	1.000	1.000	1.000
Problem Solving	0.778	0.550	0.592

As shown in Table 3, all variables exhibit high composite reliability within the model. The composite reliability for all variables exceeds 0.7, indicating an appropriate model fit according to this criterion. Fornell and Larcker (1981) identified 0.7 as the cutoff value for this measure.

Additionally, the convergent validity—which represents the average variance extracted (AVE) and reflects the correlation between a construct and its indicators—is higher than 0.5 for all variables. This confirms the convergent validity of the model and indicates a good fit for the measurement model. In other words, each latent variable is able to explain more than half of the variance in its observed indicators. Therefore, the model employed in this study demonstrates satisfactory quality.

Furthermore, the Q^2 values are above zero, which overall indicates that the model performs well in predicting the corresponding endogenous variables.

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4. Discussion and Conclusion

The present study aimed to investigate the relationship between self-directed learning and problem-solving, with the mediating role of academic self-efficacy and the moderating role of gender among students at Al-Qadisiyah University in Iraq. The results indicated that self-directed learning has a direct effect on problem-solving; specifically, as self-directed learning increases, problem-solving ability also improves. The greatest impact was observed on constructive problem-solving styles, such as creativity, while the least effect was seen on unconstructive styles, such as helplessness in problem-solving.

Moreover, self-directed learning demonstrated indirect effects on problem-solving through the mediation of academic self-efficacy. In other words, as academic self-efficacy increases, the effect of self-directed learning on problem-solving is enhanced. Gender played a moderating role in the relationship between academic self-efficacy and problem-solving, with differences observed between males and females in problem-solving performance.

Overall, the model assessment showed good fit indices, confirming the validity of these findings.

The research findings on the direct effect of self-directed learning on problem-solving are consistent with the prior studies (Hamed et al., 2023; Hwang & Oh, 2021). This can be explained as follows: as previously mentioned, problem-solving is a reflective judgment process that monitors implementation and outcomes and adjusts strategies/actions accordingly. The execution of this process requires self-directed learning (Canniford & Fox-Young, 2015; Hendricson et al., 2006). In self-directed learning, learners take control of their learning process, identify their learning needs, set their goals, recognize the necessary resources (material and human), select and implement appropriate learning strategies, and evaluate their learning outcomes (Soleymani et al., 2021). Self-directed learning enables learners to independently and proactively pursue their learning path. This approach fosters self-motivation, effort, independence, self-confidence, and goal-orientation, and by employing cognitive and metacognitive techniques, learners can discover new and creative ways to learn and solve problems. This process includes exploration, independent learning, and evaluation, which improve problem-solving ability and consequently enhance academic performance and student progress.

The findings regarding the effect of self-directed learning on academic self-efficacy align with the prior studies (Hwang & Oh, 2021; Ranjbar et al., 2019; Yi et al., 2024). This can be explained by the fact that self-efficacious individuals possess traits such as curiosity and inquiry, which are also essential in self-directed learning (as cited in (Karakurt & Şeker, 2020)). Therefore, self-efficacy is considered a component of self-directed learning. A person practicing self-directed learning must constantly self-evaluate and have the sense of self-efficacy and capability to better perform tasks and achieve goals. Moreover, previous research has shown that teaching cognitive and metacognitive strategies can help reduce academic self-handicapping and increase self-directed learning in students (Soleymani et al., 2021). Furthermore, past studies, including Alamolhoda and Zeinali (2022), indicate that metacognitive skills, which are part of self-directed learning, play a role in various cognitive activities, and their enhancement leads to greater success and increased self-efficacy (Alamolhoda & Zeinali, 2022). Achieving positive outcomes in self-directed learning strengthens a person's sense of ability, confidence, independence, and self-efficacy. This is because past successes increase efficacy beliefs, whereas repeated failures diminish them. In fact, self-efficacy arises when an individual perceives that they are performing well (as cited in (Artino, 2012)).

The results of the study indicating that academic self-efficacy plays a mediating role in the relationship between self-directed learning and problem-solving, and that gender serves as a moderating factor in this relationship, are consistent with the prior findings (Hamed et al., 2023; Hwang & Oh, 2021; Jakhar, 2019; Karakurt & Şeker, 2020).

In explaining the mediating role of self-efficacy in the relationship between self-directed learning and problem-solving, it can be said that self-efficacy is an essential component of personal agency, or the belief that an individual can exert significant control over important life events. This belief can have a considerable impact on problem-solving skills. Individuals with high self-efficacy tend to be optimistic about worldly events, are usually able to successfully complete tasks, show greater resilience to adverse events, and persist until they reach their goals (Bandura et al., 2001). Therefore, a self-efficacious person actively strives to find solutions when facing a problem and does not give up until the goal is achieved. Self-efficacious individuals pursue success with confidence and persistent effort, resist failures without viewing them as the end of the road, and confront challenges instead of avoiding them. These individuals act with self-belief in difficult situations

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and are capable of controlling stress before any performance (Maiger, 2018; Zander et al., 2018).

Students who utilize self-directed learning skills feel more mastery over their performance and possess higher self-efficacy. These self-efficacious individuals, equipped with metacognitive abilities, use appropriate maps and strategies to analyze and solve problems and have focus and control over their cognitive processes. These abilities equip the individual to adapt to challenges and find solutions to problems with a critical and logical analytical perspective.

Regarding the moderating role of gender in the relationship between academic self-efficacy and problem-solving, research has shown that men and women differ in academic performance in reading and writing, mathematical calculations, and problem-solving, and these differences arise due to structural differences in male and female brains. For example, women's brains have a higher volume of gray matter in Broca's area, responsible for language processing, which leads to better abilities in reading and writing. Neurological studies have also shown that faster brain development with better cognitive abilities for self-control and self-regulation among girls results in greater engagement in learning activities, placing them at higher levels of academic performance. Meanwhile, boys show more interest and higher self-efficacy than girls in mathematics (Chow & Croxton, 2017).

The limitations of the present study include the use of non-random convenience sampling and the lack of homogeneity of the sample regarding field of study and academic level, which may affect the results. Additionally, this was a cross-sectional study conducted during the academic year 2023-2024 on students at the University of Qadisiyah, Iraq. Therefore, caution should be exercised in generalizing the results to other time periods and locations. It is recommended that similar studies be conducted in different time frames and locations using cluster random sampling to include individuals with diverse demographic and cultural characteristics. It is also suggested that future research focus on more homogeneous groups, such as students from a specific field or academic level, to achieve more accurate results.

Given the impact of self-directed learning on problem-solving and self-efficacy, it is recommended that professors and educational administrators in higher education encourage and guide students toward self-directed learning, and organize training courses to enhance self-directed learning skills and increase self-efficacy with attention to gender differences.

Authors' Contributions

All authors significantly contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

In this study, to observe ethical considerations, participants were informed about the goals and importance of the research before the start of the study and participated in the research with informed consent.

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