Iranian Journal of Learning and Memory
Iranian Educational Psychology Association
Homepage: https://journal.iepa.ir
Print ISSN: 2645 - 5455
Online ISSN: 2645 - 5457

Structural Equation Modeling of Students' Sense of Responsibility and Teachers' Formative Assessment with the Mediating Role of Self-Regulated Learning Strategies

Hasan Khalajipour[1], and Mohammad Mojtabazadeh[2] ✉

1. Department of Educational Sciences, Zanjan Branch, Islamic Azad University, Zanjan, Iran. E-mail: khalajihasan1371@gmail.com
2. *Corresponding author*, Department of Educational Administration, Farhangian University, P.O. Box 14665-889, Tehran, Iran.. E-mail: m.mojtabazadeh@cfu.ac.ir

Article Info

Article type:
Research Article

Article history:
Received April 28, 2024
Received in revised form June 25, 2024
Accepted July 04, 2024
Published online July 05, 2024

Keywords:
formative assessment,
self-regulated learning strategies,
students,
sense of responsibility

ABSTRACT

Objective: The aim of this study was to model the structural equations of students' sense of responsibility and teachers' formative assessment with the mediating role of self-regulated learning strategies in students.

Method: The research adopted an applied descriptive-correlational method and quantitative approach. The statistical population included all junior high school students in Zanjanroud district of Zanjan province in the academic year 2023-2024, totaled as 258 people. Considering the number of latent and observed variables in the present study and also the total population size (258 people), the entire population was used for SEM analyses using the census method. The research tool consisted of three questionnaires: Yousefi Afrashte et al.'s Formative Assessment Questionnaire (2014), Kordloo's Student Sense of Responsibility Questionnaire (2008), and Pintrich and De Groot's Self-Regulated Learning Strategies (1990). For data analysis, the Kaiser-Meier-Elkin test, Bartlett's test of sphericity, and structural equation modeling were used. The analyses were performed using SPSS version 28 and PLS version 4 software.

Results: The findings showed that self-regulated learning strategies, with a path coefficient of .960, a t-statistic of 150.537, and $p<0.01$, play a mediating role between teachers' formative assessment and students' sense of responsibility. Therefore, it can be stated that self-regulated learning strategies play an important role in the relationship between formative assessment and students' sense of responsibility.

Conclusions: Self-regulated strategies act as a mediating factor that helps students have a better understanding of their progress through continuous assessments and, as a result, to feel more responsible for their learning and academic results. Thus, strengthening these strategies can lead to improved educational outcomes and increased student motivation. Accordingly, it is suggested that educational programs and educational interventions be designed based on formative assessment. In particular, teachers can use formative assessment tools to provide continuous and goal-oriented feedback to help students set personal learning goals and monitor their progress. Also, holding workshops and training sessions to teach students self-regulation skills can lead to improving the quality of their learning and their sense of responsibility.

Cite this article: Khalajipour, H., & Mojtabazadeh, M. (2024). Structural Equation Modeling of Students' Sense of Responsibility and Teachers' Formative Assessment with the Mediating Role of Self-Regulated Learning Strategies. *Iranian Journal of Learning and Memory*, *7* (26), 71-91. DOI: http//doi.org/10.22034/iepa.2024.471505.1495

© The Author(s).
Publisher: Iranian Educational Research Association.
DOI: http//doi.org/10.22034/iepa.2024.471505.1495

Introduction

In today's world, self-regulated learning is recognized as a fundamental skill in the educational process. Self-regulation refers to the ability of an individual to manage and regulate their own learning and includes skills such as planning, self-monitoring, and evaluation (Efklides, 2011). These skills help students to actively engage in their learning process, pursue specific goals, and evaluate and regulate their progress (Pintrich, 2000). Self-regulated learning strategies, as a key learning strategy, allow students to actively participate in their learning process. This type of learning helps them achieve their goals with greater confidence and, when faced with challenges, to continue learning with greater effort and perseverance instead of feeling helpless. Research shows that teaching self-regulated strategies can lead to improved academic performance and increased motivation in students (Zimmerman, 2002). Also, a lack of self-regulation skills can lead to a decrease in their motivation and academic success (Räisänen et al., 2016).

On the other hand, teaching self-regulatory strategies can lead to improved academic performance and increased motivation in students (Mammadov & Schroeder, 2023). Therefore, self-regulated learning is recognized as a fundamental skill in the educational process. Self-regulation refers to the ability of an individual to manage and regulate their own learning (Panadero, 2017). Also, self-regulation allows students to use effective learning strategies and continuously improve their academic performance (Boekaerts, 1999). Self-regulated learning strategy refers to a set of processes and skills that help students manage their learning effectively. These strategies include planning, monitoring progress, and evaluating learning outcomes, and allow students to participate independently and actively in their learning process (Panadero, 2017). In other words, self-regulated learning strategy helps learners set their learning goals, identify necessary resources, and adjust their learning methods based on the feedback received (Zimmerman, 2012).

This process not only helps improve academic performance, but also leads to the development of metacognitive and motivational skills (Schunk & Zimmerman, 2008). In general, self-regulated learning refers to an ongoing learning process in which individuals actively control and monitor their thoughts, motivations, behaviors, and emotions to achieve their desired goals (Molnar, 2025). Self-regulated learning and formative assessment mutually influence each other, thus, the use of formative assessment can help students strengthen self-regulated skills in their learning process. Also, this type of assessment provides continuous and corrective feedback opportunities that allow learners to gain a better understanding of their progress and weaknesses (Nicol & Macfarlane-Dick, 2006).

Therefore, formative assessment, as a tool for assessing students' progress during the learning process, can help foster a sense of responsibility in them (Butler & Winne, 1995). Formative

assessment, commonly known as “assessment for learning,” is a collaborative process designed to identify learning goals, gather evidence, and provide feedback that helps students progress. It also serves as a reliable source of information and helps teachers make better instructional decisions (Yang, 2025). Formative assessment refers to the process of evaluating and collecting information during learning with the aim of improving learning and teaching. It helps teachers and students to continuously monitor learning progress and make appropriate instructional decisions based on it. Formative assessment allows learners to identify their strengths and weaknesses and make improvements in their learning process by receiving immediate and constructive feedback.

In other words, formative assessment, as an interactive and flexible tool, helps learners and teachers to achieve educational goals more effectively and turn learning into an active process (Hattie & Timperley, 2007). Formative assessment, as a tool for assessing students' progress during the learning process, can help strengthen their sense of responsibility. By using this type of assessment, students can receive continuous and useful feedback that helps them identify their strengths and weaknesses and, in this way, they gain a greater sense of responsibility for their own learning (Black & Wiliam, 1998). Formative assessment can enhance students' sense of responsibility because this type of assessment allows them to actively participate in their learning process and benefit from continuous feedback, which in turn increases their commitment and responsibility for learning (Hattie & Timperley, 2007).

On this basis, a sense of responsibility in students means their ability and willingness to accept and perform tasks related to learning and social behaviors. This concept includes awareness of the effects of individual actions on themselves and others, as well as a commitment to do things in the best possible way (Ayish & Deveci, 2019). A sense of responsibility in the field of students' learning means accepting and performing tasks related to learning and personal growth. This concept includes not only the individual responsibilities of students but also the responsibilities of teachers and the education system. A sense of responsibility in the field of education is defined as “a feeling of internal and obligatory commitment to produce or prevent specific results”. This feeling includes a deep understanding of one's role in the learning process and its impact on educational outcomes. By accepting responsibility for their own learning, students can be more active and effective in the learning process (Kuhlmann, 2022). In terms of the learning environment, teachers should provide an environment in which students feel responsible which includes providing appropriate feedback, building positive relationships, and supporting students' mental health (Milfont & Sibley, 2016).

In light of the above, formative assessment plays a vital role in the learning process and allows teachers to identify students’ strengths and weaknesses by providing continuous feedback. This type of assessment helps students to actively participate in their learning process and feel more responsible for their own learning (Nicol & Macfarlane-Dick, 2006). Also, formative assessment

can allow students to set their own goals and evaluate their performance based on them, which ultimately leads to increased accountability (Hattie & Timperley, 2007).

In this regard, previous research suggests that self-regulated learning strategies act as a mediating variable between formative assessment and sense of responsibility, as they not only increase intrinsic motivation but also facilitate the better control of the educational process (He et al., 2024; Li & Gu, 2024; Prompan & Piamsai, 2024). Accordingly, research on the main issue of the present study can be divided into several categories. The first category includes studies that examined the relationship between formative assessment and self-regulated learning strategies. For example, He et al. (2024) used process extraction techniques to analyze changes in self-regulated learning patterns after a formative assessment. Also, Luo and Lim (2024) examined the relationship between perceived formative assessment and students' motivational beliefs by conducting a multilevel analysis. In addition, Li and Gu (2024) studied a teacher professional development program for formative assessment that emphasizes self-regulated learning.

In the second category of research, self-regulated learning and motivation were considered. Prompan and Piamsai (2024) showed the positive effect of peer feedback and self-regulated learning on Thai students' English writing ability. Hudesman et al. (2014) also presented a multi-faceted program to help students with developmental mathematics using formative assessment and self-regulated learning. The third category involves formative assessment in the educational environment. This shows the importance of live interactions in the educational process. For example, Nieminen et al. (2024) examined different forms of formative assessment discussions in a physics classroom to determine how they can be used. Grob et al. (2024) analyzed formal formative assessment activities in Swiss primary schools. In the fourth category of research, the effects of formative assessment have also been considered. For example, Bellido-García et al. (2024) examined the impact of formative assessment on the development of students' competence, showing how this type of assessment can play an important role in increasing student engagement. In the fifth category, formative assessment tools in education are presented, which can also be used in other fields (Alkhateeb, 2024).

Accordingly, the lack of self-regulatory skills can lead to a decrease in students' motivation and academic success (Räisänen et al., 2016). This issue becomes especially important in academic courses that require more independence in learning. Therefore, the present study examined how self-regulatory strategies can help strengthen students' sense of responsibility and ultimately lead to improved learning quality. In addition, formative assessment, as a tool for measuring students' progress during the learning process, can help strengthen their sense of responsibility. This type of assessment provides students with continuous and useful feedback that helps them identify their strengths and weaknesses (Murray & Rosanbalm, 2017).

Investigating the mediating role of self-regulation strategies in this process is of great importance and necessity, as it can help develop more effective teaching methods and improve the quality of learning. Given this importance, it is expected that the results of this study would lead to a deeper understanding of the relationships between self-regulation, formative assessment, and a sense of responsibility in students and help design more effective educational programs in this area. Therefore, a better understanding of these relationships can lead to improved educational methods and learning quality. This study also seeks to fill the gaps in research and provide solutions to strengthen self-regulation skills and a sense of responsibility in students. The research background shows that formative assessment and self-regulated learning strategies play an important role in strengthening students' sense of responsibility. Various studies, including those of Nieminen et al. (2024) and Grob et al. (2024) identified effective methods for collecting data and analyzing formative assessment activities that can help teachers improve students' learning mindsets and behaviors. He et al. (2024) also found that high-performing students demonstrated more self-regulatory behaviors after formative assessment, which helped enhance their sense of responsibility.

In addition, research done by Hudesman et al. (2014) and Luo and Lim (2024) pointed to a positive relationship between students' perceptions of formative assessment and motivational beliefs and self-regulatory strategies. These findings indicate that formative assessment not only serves as a tool for measuring students' progress, but can also lead to strengthening their motivation and responsibility. Given this background, the present research problem was dedicated to examining the mediating role of self-regulated learning strategies in the relationship between formative assessment and students' sense of responsibility. Considering the above, the main question of this research was posed as follows:

- What is the mediating role of self-regulated learning strategies in the relationship between formative assessment and students' sense of responsibility?

The conceptual model of the research is presented in Figure 1.

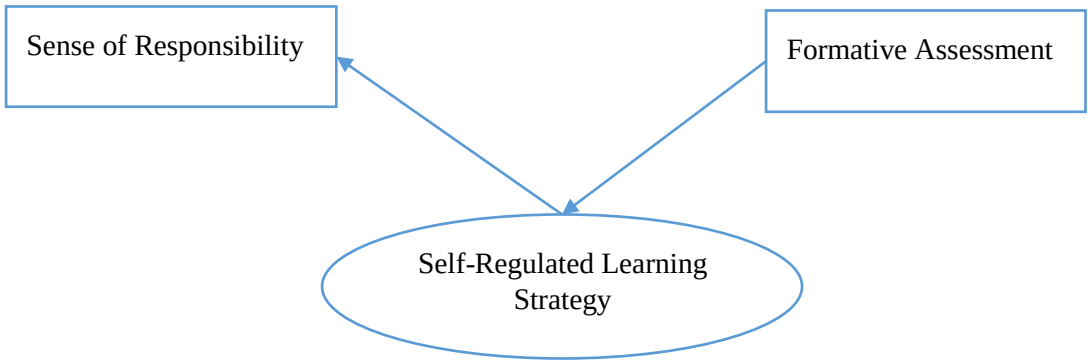

Figure 1. The Research Conceptual Model

Materials and Methods

Design of the Study

The present study employed an applied descriptive-correlational method and quantitative approach (Hassanzadeh et al., 2022).

Participants

The statistical population of the study included all junior high school students in Zanjanroud district of Zanjan province in the academic year 2023-2024. The number of the students was 258 people. Given that in structural equation modeling analysis, on the one hand, the number of sample individuals for each latent variable should be 5 to 10 people, and on the other hand, the number of sample individuals should be at least 200 people (Kline, 2023; MacCallum et al., 1999), the entire population (258 people) was used as a sample using the census method. In this study, out of a total of 258 students, 139 (%53.9) were female and 119 (%46.1) were male students. These data indicate that female students shaped the majority in this sample and the gender ratio is in favor of them. Also, the distribution of students across the three grades is as follows: 53 (%34.9) were in the seventh grade, 51 (%33.6) in the eighth grade, and 48 (%31.6) were in the ninth grade. This distribution indicates that students are relatively balanced across grades; however, the first grade has the largest part.

Instruments

Formative Assessment Questionnaire by Yosefi Afrashteh et al. (2014): A Formative Assessment Questionnaire designed by Yosefi Afrashteh et al. (2014) was used to assess the teacher's formative assessment approach. This questionnaire consists of 8 questions with a five-point Likert scale from strongly disagree to strongly agree with scores from 1 to 5 to identify the teacher's classroom assessment approach. The scores of this questionnaire range from 8 to 40; with

higher scores indicating that the teacher uses more formative assessment. The reliability coefficient of this questionnaire for the 8 classroom assessment approach questions in the study by Yosefi Afrashteh et al. (2014) was reported to be .72, indicating a relatively high reliability of the tool. Also, the reliability of this tool in the study by Yousefi Afrashteh and Dehghani (2021) was obtained as .82 using the Cronbach's alpha method.

Pintrich and De Groot Self-Regulated Learning Strategies Questionnaire (1990): The Self-Regulated Learning Strategies Questionnaire developed by Pintrich and De Groot is structured with 47 items in two sections: motivational beliefs and self-regulated learning strategies (cognitive and metacognitive strategies). The self-regulated learning strategies subscale consists of 22 items and measures three aspects of academic self-regulation, namely cognitive strategies, metacognitive strategies, and resource management. Cognitive strategies have 13 items. The components of the questionnaire are divided into two categories.

The items in the cognitive strategies section include: repetition and review (items 29-37-44), elaboration including note-taking (item 34), summarizing (items 31-45), organizing (items 26-27-39-42-47), and comprehension (items 32-33). In the metacognitive strategies and resource management section, there are 9 scale items including planning (items 38-46), monitoring and control (items 28-35-41-43), organizing (effort and perseverance) (items 30-36), and organizing activity (item 40). The motivational beliefs section includes 25 scale items: self-efficacy (items 22-21-19-14-12-10-9-6-2), goal orientation (items 1-4-11-16-24), intrinsic valuation (items 5-8-17-20), and test anxiety (items 3-7-13-15-18-23-25). The questionnaire is scored as follows: Strongly agree (5), agree (4), no opinion (3), disagree (2), and strongly disagree (1). For data analysis, it is necessary to add the scores obtained from the 47 items together. The minimum possible score is 47 and the maximum is 235. A score between 47 and 94 indicates low use of self-regulated learning strategies, a score between 94 and 141 indicates moderate use of these strategies while a score above 141 indicates high use of self-regulated learning strategies. Considering the reliability of this questionnaire, Pintrich and De Groot (1990) obtained three factors for the motivational beliefs scale: self-efficacy, intrinsic valuation, and test anxiety, and two factors for the self-regulated learning strategies scale: use of cognitive strategies, use of metacognitive strategies, and resource management. The reliability coefficients of the subscales of self-efficacy, intrinsic valuation, and test anxiety, and use of cognitive and metacognitive strategies were determined to be .89, .87, .75, .83, and .74, respectively.

Kordlou's Responsibility Questionnaire (2008): This questionnaire was developed by Kordlou (2008) to measure the level of responsibility of students at home and school. The questionnaire has 5 scales, the first scale asks about the student's activities inside and outside of school, respectively. In this question, one score is assigned to each item and the sum of the options shows the level of student activities. The second scale asks about the students' responsibilities at

home. One score is assigned to each option and the sum of the options shows the level of responsibility of the subject at home. The purpose of the second scale is to compare the subject's responsibility in the educational environment and at home. The third scale asks about the subject's absence and tardiness. The fourth and fifth scales of the questionnaire measure the level of responsibility, sense of security, self-esteem and belonging. This tool was administered to a statistical population of students in Tehran, in which 479 male and female students were tested. The validity of this test was .82 through the correlation of questions, and its reliability using Cronbach's alpha coefficient was .89, which indicates the high validity and reliability of the tool.

The steps in creating the measurement tool were as follows: First, in order to identify the factors affecting students' responsibility, school administrators, teachers, and parents were asked to provide their opinions in writing about these factors. Then, after determining the research question and hypothesis, a questionnaire was designed to measure the level of responsibility and the influencing factors. This questionnaire was administered to a group of administrators, instructors, teachers, and students, as well as some university professors, to collect their corrective opinions. The questionnaire was then administered and validated on samples with 35 and 104 people. Finally, for the third time, the questionnaire was administered to 482 students in Tehran, and the results of the evaluations showed that this tool has a high validity of .90. The scoring method for the different scales of the questionnaire is as follows: To measure the sense of security, the scores of the 14 relevant questions are summed and form the participants' sense of security. In the case of self-esteem, positive and negative items are scored in reverse. The sense of belonging is also assessed in the same way. Responsibility includes both external commitment and internal commitment, which do not include negative scores. Scoring is in the form of a 4-option Likert scale, with positive items ranging from completely satisfied (4) to not satisfied at all (1), and negative items are scored in reverse.

Procedure

Before beginning the research, the purpose of the study was explained to the participants and they were assured that the researchers were committed to maintaining their privacy and confidentiality. Also, an informed consent form was obtained from the participants. After that, to collect the data, three questionnaires of formative assessment, sense of responsibility, and self-regulated learning strategies were administered to the participants. Then, the Kaiser-Meier-Elkin test, Bartlett sphericity test, and structural equation modeling were used to analyze the data.

Results

After administering the questionnaires, their validity and reliability were calculated. In Tables 1 and 2, the results of the validity coefficients and reliability coefficients are reported.

Table 1. Reliability and Convergent Validity Coefficients

Variables	Reliability			Convergent Validity
	Cronbach	Rho	Composite	Mean extracted variance
Sense of Responsibility	.962	.953	.950	.836
Self-regulated Learning Strategies	.973	.946	.945	.948
Formative Assessment	1.000	1.000	1.000	1.000

Table 1 displays the reliability and convergent validity coefficients of the research variables. For the variable 'sense of responsibility', Cronbach's reliability is .950, Rho coefficient reliability is .953, composite reliability is .962, and the average extracted variance is .836. These values indicate a very high reliability of this variable, and in particular, the Cronbach's reliability value is higher than .900 and the average extracted variance is also higher than .800 indicating the convergent validity and high reliability of this variable. For the variable 'self-regulated learning strategies', Cronbach's reliability is .945, Rho coefficient reliability is .946, composite reliability is .973, and the average extracted variance is .948. These values also indicate the high reliability and validity of this variable, and the Cronbach's alpha and composite reliability values emphasize that this variable can measure its construct well. In the case of the 'formative assessment' variable, the values presented for Cronbach's alpha, Rho coefficient, composite reliability, and mean extracted variance are also equal to 1.000. In general, all variables have high convergent reliability and validity.

Table 2. Divergent Validity Coefficients (Fornell and Larker Test)

Variable	Self-Regulation Learning Strategies	Formative Assessment	Sense of Responsibility
Self-Regulation Learning Strategies	.960		
Formative Assessment	.944	.974	1.000
Sense of Responsibility	.914	.942	

Table 2 shows the divergent validity coefficients (Fornell and Larker test) for the research variables. In this table, the values related to divergent validity for the three variables 'self-regulated learning strategies', 'formative assessment' and 'sense of responsibility' are presented. For the variable 'self-regulated learning strategies', the divergent validity value is .960. This indicates that this variable is well distinguished from other variables and has a high internal correlation. In the case of the variable 'formative assessment', the divergent validity value is reported to be 0.974. This high value of divergent validity indicates that this variable is also effectively separated from other variables and has a good correlation with itself. The variable 'sense of responsibility' also has a divergent validity value of 1.000. These values indicate that 'sense of responsibility' is well

distinguished from other variables and has a strong internal correlation. In general, the results of this table indicate appropriate divergent validity for the research variables.

Before structural equation modeling, it is necessary to perform the Kaiser-Meier-Olkin (KMO) test and the Bartlett test of sphercity. The Kaiser-Meier-Olkin (KMO) test is known as a key criterion for assessing the adequacy of sampling. If the KMO value is greater than .6, it indicates that the conditions are met for conducting path analysis and structural modeling. The Bartlett test of sphercity also examines the significance of the data matrix, and its significance is a basic condition for conducting statistical analyses. If this test shows that the data matrix is significant, researchers can proceed with further analyses with more confidence. The results of the Kaiser-Meier-Olkin and the Bartlett test of sphercity are presented in Table 3.

Table 3. Values of the Kaiser-Meier-Olkin and the Bartlett of Sphercity Tests

Sampling adequacy index (Kaiser-Meier-Elkin test)		.877
Bartlett's test of Sphericity	Chi-square Statistic	2197/137
	Degree of Freedom	28
	Significance Level	.000

The values of the Kaiser-Meier-Elkin test and the Bartlett test of sphercity presented in Table 3 clearly indicate the appropriate quality of the data for statistical analyses. The sampling adequacy index in the Kaiser-Meier-Elkin test is .877, which is well above the threshold of .700. This value emphasizes that the sampling conducted is appropriate for factor analysis. Also, the results of the Bartlett test of sphercity, with a chi-square statistic of 2197.137 and a significance level of .000, indicate the significance of the correlation matrix between the variables. This finding clearly indicates that the null hypothesis of no correlation between the variables is rejected, thus allowing further analyses to be conducted with greater confidence.

Therefore, structural equation modeling was used to test the hypothesis that self-regulated learning strategies mediate between formative assessment and sense of responsibility among students. The results obtained from this modeling are shown in Table 5 and Figures 2 and 3. The data show that the path coefficients between the latent variables and the observable variables have exceeded the standard significance level (more than .30) and have reached a level that is not only statistically significant, but also has a significant impact and power. In addition, the results of the bootstrap t-test clearly indicate the significance of the effects of the latent variables on the observable variables.

Table 4. Descriptive Statisitcs of the Variables

Variable	Mean	SD	Median	Minimum	Maximum
Formative assessment	4.20	.65	4	2	5
Self-Regulation Learning Strategies	4.15	.70	4	1	5
Sense of Responsibility	3.80	.50	4	2	5

According to Table 4, for 'formative assessment', the average score is 4.20 with a standard deviation of .65 and a median of 4. The minimum score recorded was 2 and the maximum score was 5. For 'self-regulated learning strategies', the average score is 4.15 with a standard deviation of .70 and a median of 4. In this variable, the minimum score is 1 and the maximum score is 5. For 'sense of responsibility', which is measured on a 4-point Likert scale, the average score is 3.80 with a standard deviation of .50 and a median of 4.00. The minimum score in this category is 2 and the maximum score is 4.

Table 5. Results of the Path Coefficient and Bootstrap of the Effect of Latent Variables on Observed Variables

Latent variable	Observed variable	Path Coefficient	t-statistic	Type of Effect	Path Coefficient Result	t-Statisitc Result
Formative Assessment	Formative assessment	1.000	-	direct	0.30<Confirm	--
Self-regulated Learning Strategies	Motivational Beliefs	.974	437.853	direct	0.30<Confirm	2.58<Confirm
	Self-regulated Learning Strategies	.973	399.450	direct	0.30<Confirm	2.58<Confirm
Sense of Responsibility	Student Activities Inside and Outside the Home	.863	42.820	direct	0.30<Confirm	2.58<Confirm
	Student Responsibilities at Home	.912	64.498	direct	0.30<Confirm	2.58<Confirm
	Student Absenteeism and Delay	.881	16.337	direct	0.30<Confirm	2.58<Confirm
	Sense of Responsibility and Security	.924	23.091	direct	0.30<Confirm	2.58<Confirm
	Self-Esteem and Sense of Belonging	.986	429.098	direct	0.30<Confirm	2.58<Confirm

The results of the study show that latent variables play an important role in the characteristics that are revealed in the observed variables of the study. These findings clearly show the important and significant effects of latent variables on observed variables. The results of structural equation modeling are presented in Table 6 and Figures 2 and 3.

Table 6. Results of the Path Coefficient and Bootstrap of the Direct and Indirect Effects of the Relationship between Variables

Relationship Path			Type of Effect	Path coefficient	t-statistic	P
Formative Assessment	->	Self-Regulated Learning Strategies	Direct	.942	100.305	.000
Formative Assessment and Self-Regulated Learning Strategies	->	Sense of Responsibility	Indirect	.960	152.113	.000

Table 6 presents the results of the path coefficient and bootstrap of the direct and indirect effects of the relationship between the variables. In this table, the direct effect of formative assessment on self-regulated learning strategies is reported with a path coefficient of .942, a t-statistic of 97.617, and a significance level of .000. These results indicate that formative assessment has a direct and strong effect on self-regulated learning strategies. The path coefficient of .942 indicates a high correlation between the two variables, and the t-statistic and significance level indicate that this effect is statistically significant. In other words, changes in formative assessment significantly affect self-regulated learning strategies. In addition, the indirect effect of formative assessment and self-regulated learning strategies on sense of responsibility has also been examined. In this case, the path coefficient is .960, the t-statistic is 150.537, and the significance level is .000. These values indicate that these two variables jointly have a significant effect on sense of responsibility, and their indirect effect is also statistically significant. This means that formative assessment and self-regulated learning strategies indirectly affect sense of responsibility. Generally, the results in Table 5 indicate strong and significant effects of formative assessment on self-regulated learning strategies, as well as the indirect effect of these two variables on sense of responsibility.

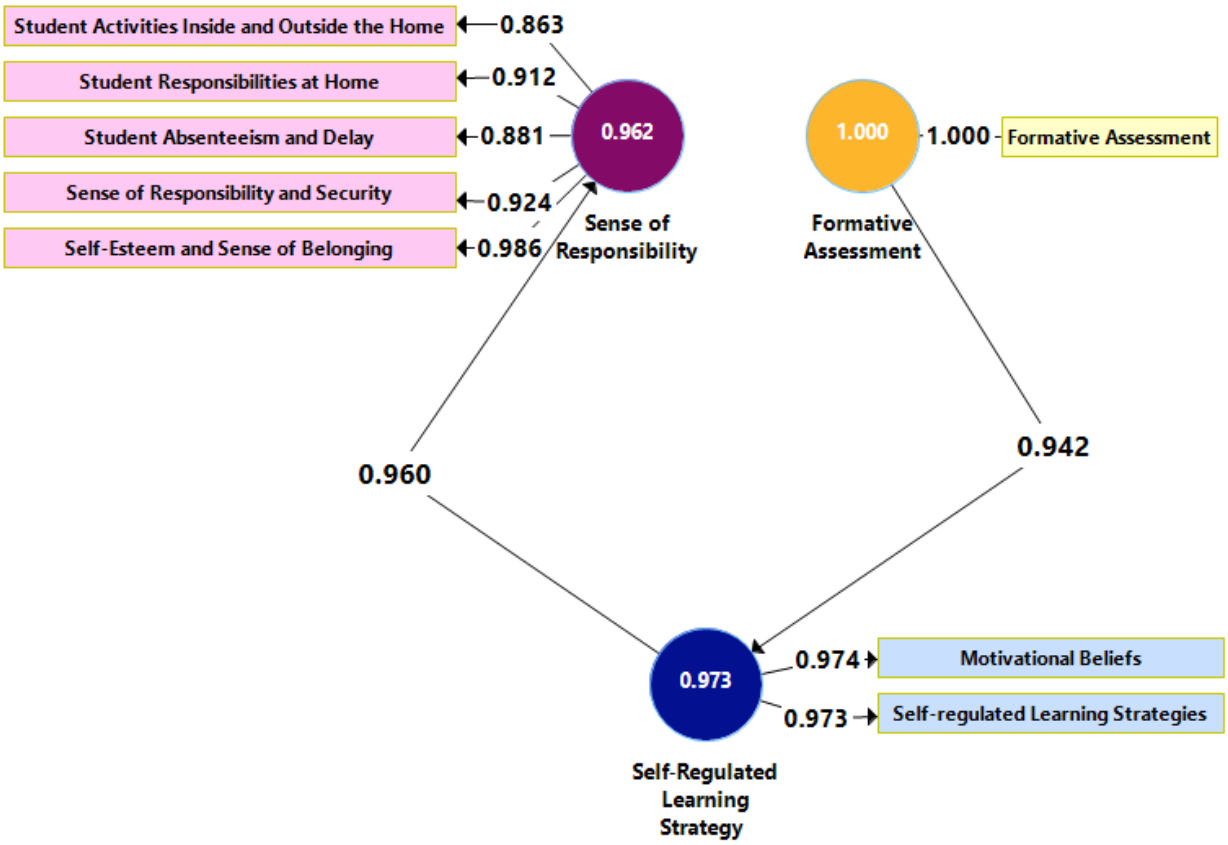

Figure 2. Composite Reliability and Path Coefficients of the Relationship between Formative Assessment and Sense of Responsibility through the Mediation of Self-Regulated Learning Strategies

Figure 2 examines the composite reliability and path coefficients of the relationship between formative assessment and sense of responsibility through the mediation of self-regulated learning strategies. This figure shows how the formative assessment variable, as an independent variable, affects sense of responsibility through the mediating variable of self-regulated learning strategies. In this analysis, composite reliability was used as a criterion for assessing the internal consistency of the measures. High composite reliability values indicate that the measurement instruments used in the study are well correlated with each other and can effectively measure the desired characteristics. Path coefficients also indicate the intensity and type of relationship between the variables. A high path coefficient from formative assessment to self-regulated learning strategies indicates a strong effect of this variable on the mediating variable.

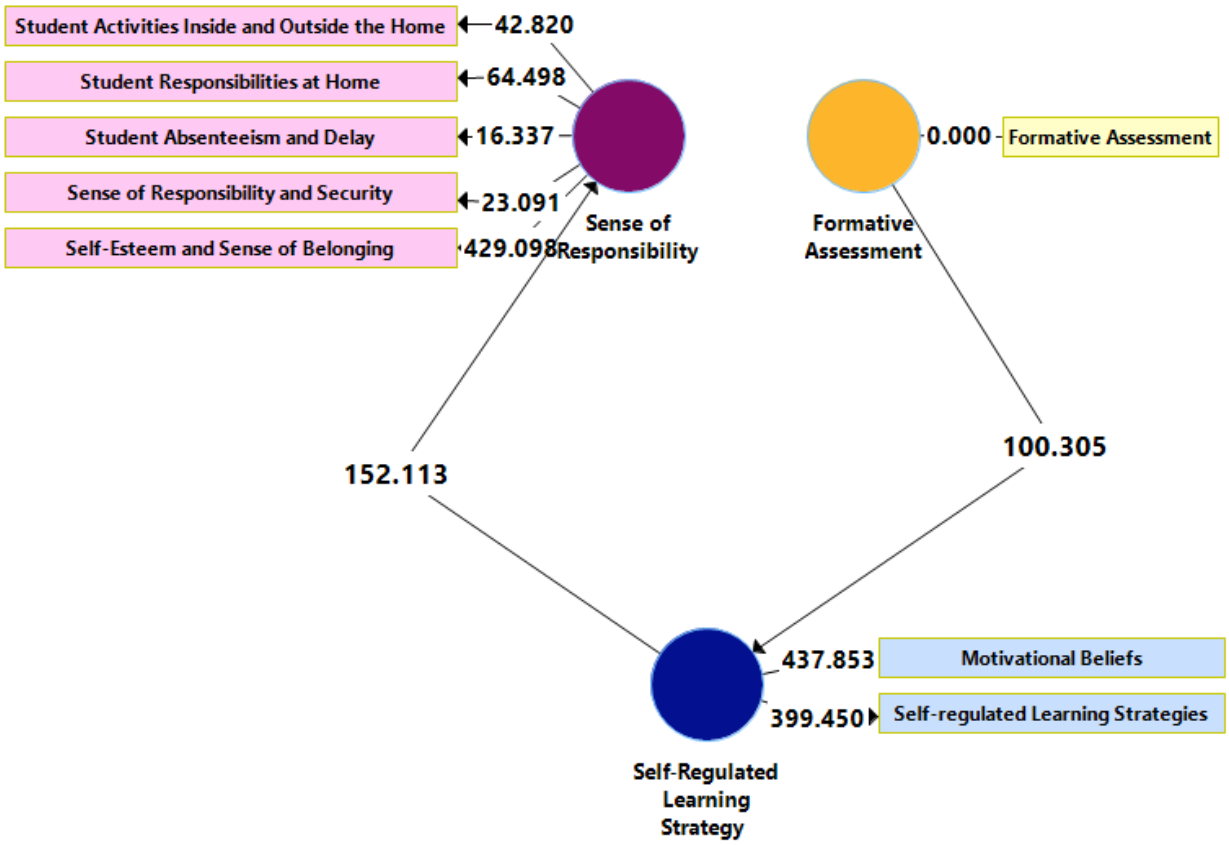

Figure 3. Bootstrap Values of the Relationship between Formative Assessment and Sense of Responsibility through the Mediation of Self-Regulated Learning Strategies

Figure 3 examines the bootstrap values of the relationship between formative assessment and sense of responsibility through the mediation of self-regulated learning strategies. This figure shows how the formative assessment variable can affect sense of responsibility through self-regulated learning strategies. Bootstrap values are used as a statistical method to assess the accuracy and validity of structural equation modeling results. This method allows us to obtain approximate distributions for the estimates using resampling and thus ensure more confidence in the results obtained. In this figure, bootstrap values are presented for the direct and indirect effects between formative assessment and sense of responsibility through self-regulated learning strategies. These values show researchers how changes in formative assessment can affect sense of responsibility by influencing self-regulation strategies. Table 7 presents the partial least squares fit indices.

Table 7. Partial Least Squares Fit Indices

Index	Value	Acceptable criterion	Result
Root Mean Square Standard Residual Index	.059	Less than 0.1	Confirmed
True Model Fit Criterion d_ULS	.126	Interpretation based on normal fit index	Confirmed
True Model Fit Criterion d_G	.675	Interpretation based on normal fit index	Confirmed
Normal Fit Index	.792	More than 0.7	Confirmed

Table 7 examines the partial least squares (PLS) fit indices to assess the quality of the structural model of the research. In this table, the standard root mean square residual (SRMR) index is presented with a value of .059, whose acceptable criterion is less than .1, and its result is confirmed. The SRMR value less than .1 indicates that the difference between the observed correlations and the model correlations is acceptable and the model has a good fit. Also, the goodness of model fit criteria (d_ULS and d_G) is reported with values of .126 and .675, both of which are confirmed. These values indicate that the model has a good fit and is consistent with the observed data. Finally, the normalized fit index (NFI) is presented with a value of .792, whose acceptable criterion is more than .7, and its result is also confirmed. An NFI value greater than .7 indicates that the model has an acceptable fit and can be considered as a suitable model. Overall, the results of this table indicate that the structural model of the research has an appropriate fit and can be used as a reliable model in statistical analyses.

Discussion

The main objective of this research was to structurally model 'formative assessment' and 'sense of responsibility' with the mediating role of 'self-regulated learning strategies' among students. Based on the findings, the hypothesis that self-regulated learning strategy plays a mediating role between formative assessment and sense of responsibility among students has been confirmed. Self-regulated learning strategies play a mediating role between teachers' formative assessment and students' sense of responsibility with a path coefficient of .960, t-statistic of 150.537 and $p<0.01$. The results of this research are consistent with those of Alkhateeb (2024), Allahverdiani et al. (2024), Ayish and Deveci (2019), Bellido-García et al. (2024), Boekaerts (1999), Butler and Winne (1995), Efklides (2011), Grob et al. (2024), Hassanzadeh et al. (2022), He et al. (2024), Hudesman et al. (2014), Li and Gu (2024), Luo and Lim (2024), Nicol and Macfarlane-Dick (2006), Prompan and Piamsai (2024), Yosefi Afrashteh et al. (2014), Yang (2025), Zimmerman (1990), Zimmerman (2000), Zimmerman (2002), Zimmerman (2012). Accordingly, self-regulation as an effective method for changing one's thoughts, feelings, and inclinations can help improve academic engagement. Individuals with higher self-regulation skills are more active learners and have a greater ability to set goals and self-

evaluate, which leads to increased motivation and academic engagement (Pintrich & Schunk, 2002; Zimmerman, 1990).

Also, given that formative assessment refers to the process of collecting information during learning with the aim of identifying students' understanding and adjusting instruction based on their needs (Stiggins et al., 2007), this type of assessment can help increase student engagement and enhance self-regulation. Self-regulated learning strategies help students focus on their goals and improve their abilities to regulate learning (Zimmerman, 2002). Accordingly, students with higher self-regulation skills are more engaged and active in the learning process (Pintrich, 2000). In fact, self-regulation helps students feel more responsible for their learning by setting personal goals and monitoring their progress (Bandura, 1986; Zimmerman, 2000). On the other hand, formative assessment can serve as an effective tool in strengthening self-regulated strategies. When students receive consistent and constructive feedback from formative assessments, they are more likely to adjust their behaviors and become more active in the learning process (Hudesman et al., 2014).

Accordingly, in explaining this finding, it can be stated that self-regulation, as a key skill in the learning process, helps students set and plan their academic goals. This skill allows them to actively participate in their learning and feel more in control of their academic process. The feeling of control and ability to manage learning can lead to an increased sense of responsibility for their education. In addition, formative assessment, as a continuous assessment tool, allows students to observe their progress in real time and adjust their learning strategies accordingly. This type of assessment provides immediate and constructive feedback that can help improve self-regulation, and consequently, increase the sense of responsibility. The mediating role of self-regulation in this process means that self-regulation can act as a facilitating factor in the relationship between formative assessment and sense of responsibility. In other words, when students use self-regulation skills, they can use formative assessment feedback more effectively, which leads to a stronger sense of responsibility for their learning. Therefore, this hypothesis suggests that strengthening students' self-regulation skills can help improve the relationship between formative assessment and a sense of responsibility. This not only leads to increased motivation and academic engagement, but can also help improve students' academic performance.

Conclusion

Formative assessment is known as a tool for continuously assessing students' learning progress and can help teachers identify students' strengths and weaknesses and adjust instruction based on their needs (Stiggins et al., 2007). On the other hand, a sense of responsibility is known as a key factor in academic success that has a direct impact on students' motivation and academic

engagement (Pintrich & Schunk, 2002). Research has shown that students who feel more responsible for their own learning tend to use more effective self-regulated learning strategies (Zimmerman, 2002). These strategies include goal setting, self-assessment, and time management, which can lead to increased motivation and academic engagement. The present study used structural modeling to examine whether self-regulated learning strategies can play a mediating role between formative assessment and a sense of responsibility. Given the importance of this issue, the results of this study can provide practical solutions for teachers to increase students' sense of responsibility through formative assessment and strengthen self-regulation strategies, and thus facilitate the improvement of their academic performanc (Allahverdiani et al., 2024).

The present study, like all studies, suffers from some limitations. The limitations include several aspects, some of which were beyond the researcher's control. Among the limitations, the specific cultural and social characteristics of the region can be mentioned which may limit the generalizability of the results to other regions. Also, economic and infrastructural differences in educational facilities can affect the way formative assessment was implemented and, consequently, affect the results of the study. Time and space limitations may also affect the results, and the use of self-report questionnaires to measure variables may be associated with respondents' bias, which can affect the validity and reliability of the results. Regarding the statistical sample, the study only included high school students, and the generalizability of the results to other educational levels or geographical regions should be done with caution. Moreover, there were some limitations regarding the access to standardized assessment tools and the small number of students to use the sampling method. Also, the researcher faced limitations in controlling some intervening variables such as the socio-economic status of the families and the level of education of the parents, but efforts were made to use appropriate statistical methods to reduce these limitations as much as possible.

Despite the limitations, this study has valuable theoretical and practical suggestions. In the context of practical suggestions, considering the mediating role of self-regulatory strategies in the relationship between formative assessment and sense of responsibility, it is suggested that educational programs be designed to strengthen these strategies. These programs can include educational workshops, counseling sessions, and group activities in which students learn how to effectively set their goals and adjust their learning strategies based on the feedback received from formative assessment. Theoretically, it is suggested for future researchers to examine the mediating role of self-regulatory strategies in more details and in depth in other geographical areas. Studying the effect of other variables such as personality traits and educational environment on this mediating role can also help to better understand this relationship. These suggestions can help improve educational processes and future research.

Acknowledgements

This article is extracted from the master's thesis approved by the Islamic Azad University, Zanjan Branch. The authors consider it necessary to express their sincere appreciation and gratitude to the officials and professors of the Islamic Azad University, Zanjan Branch, the principals and teachers of the boy's and girl's junior high schools in Zanjanroud, the boy's and girl's junior high school students in Zanjanroud, and others who helped us in conducting and improving the quality of this research.

Conflict of interest

There are no conflicts of interest.

References

Alkhateeb, N. E. (2024). Tools of formative assessment. In *Global Medical Education in Normal and Challenging Times* (pp. 151-159). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-51244-5_17

Allahverdiani, K., Azemodeh, M., Hashemi, T., & Esmaelpour, K. (2024). The effectiveness of academic life skills and self-regulation of motivation training on academic motivation of senior high school female students. *Iranian Journal of Learning and Memory*, *6*(24), 5-14. doi: 10.22034/iepa.2024.435702.1468

Ayish, N., & Deveci, T. (2019). Student perceptions of responsibility for their own learning and for supporting peers' learning in a project-based learning environment. *International Journal of Teaching and Learning in Higher Education*, *31*(2), 224-237. https://api.semanticscholar.org/CorpusID:204383790

Bandura, A. (1986). Social foundations of thought and action. *Englewood Cliffs, NJ*, *1986*(2), 23-28. https://doi.org/10.4135/9781446221129.n6

Bellido-García, R. S., Venturo-Orbegoso, C. O., Cruzata-Martínez, A., Sarmiento-Villanueva, E. B., Corro-Quispe, J., & Rejas-Borjas, L. G. (2024). Involvement of the student in their learning: Effects of formative assessment on competency development. *EURASIA Journal of Mathematics, Science and Technology Education*, *20*, 5. https://doi.org/10.29333/ejmste/14453

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7-74. https://doi.org/10.1080/0969595980050102

Boekaerts, M. (1999). Self-regulated learning: Where we are today. *International Journal of Educational Research*, *31*(6), 445-457. https://doi.org/10.1016/S0883-0355(99)00014-2

Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research*, *65*(3), 245-281. https://doi.org/10.3102/00346543065003245

Efklides, A. (2011). Interactions of metacognition with motivation and affect in self-regulated learning: The MASRL model. *Educational Psychologist*, *46*(1), 6-25. https://doi.org/10.1080/00461520.2011.538645

Freeman, R. E., & Dmytriyev, S. (2017). Corporate social responsibility and stakeholder theory: Learning from each other. *Symphonya. Emerging Issues in Management*, *1*, 7-15.

Grob, R., Holmeier, M., & Labudde, P. (2024). Analysing formal formative assessment activities in the context of inquiry at primary and upper secondary school in Switzerland. In *Developing Formative Assessment in STEM Classrooms* (pp. 84-104). Routledge. eBook ISBN: 9781003466079

Hassanzadeh, F., Homayouni, A., sadeghi, J., & Akbarnatajshob, N. (2022). The causal relationship between HEXACO personality traits and English language anxiety with the mediating role of positive academic emotions in students. *Iranian Journal of Learning and Memory*, *5*(19), 41-49. doi: 10.22034/iepa.2022.152841

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81-112. https://doi.org/10.3102/003465430298487

He, S., Epp, C. D., Chen, F., & Cui, Y. (2024). Examining change in students' self-regulated learning patterns after a formative assessment using process mining techniques. *Computers in Human Behavior*, *152*, 108061. https://doi.org/10.1016/j.chb.2023.108061

Hudesman, J., Crosby, S., Ziehmke, N., Everson, H., Isaac, S., Flugman, B., ... & Moylan, A. (2014). Using formative assessment and self-regulated learning to help developmental mathematics students achieve: A multi-campus program. *Journal on Excellence in College Teaching*, *25*(2). eISSN 1945-2993

Kline, R. B. (2023). *Principles and practice of structural equation modeling*. Guilford publications. ISBN 978-1-4625-5191-0

Kordlou, M. (2008). Investigating the factors influencing the responsibility of high school adolescents at home and school. *Growth of School Counseling Education, 13*, 4-11. https://www.magiran.com/p551808 (in Persian)

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, *30*(3), 607-610. https://doi.org/10.1177/001316447003000308

Kuhlmann, N. (2022). On the power of the concept of responsibility. *Educational Theory*, *72*(1), 65-83. https://doi.org/10.1111/edth.12514

Li, J., & Gu, P. Y. (2024). Formative assessment for self-regulated learning: Evidence from a teacher continuing professional development programme. *System*, *125*, 103414. https://doi.org/10.1016/j.system.2024.103414

Luo, W., & Lim, S. Q. W. (2024). Perceived formative assessment and student motivational beliefs and self-regulation strategies: a multilevel analysis. *Educational Psychology*, 1-19. https://doi.org/10.1080/01443410.2024.2354686

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods*, *4*(1), 84. https://doi.org/10.1037/1082-989X.4.1.84

Mammadov, S., & Schroeder, K. (2023). A meta-analytic review of the relationships between autonomy support and positive learning outcomes. *Contemporary Educational Psychology*, 102235. https://doi.org/10.1016/j.cedpsych.2023.102235

Milfont, T. L., & Sibley, C. G. (2016). Empathic and social dominance orientations help explain gender differences in environmentalism: A one-year Bayesian mediation analysis. *Personality and Individual Differences*, *90*, 85-88. https://doi.org/10.1016/j.paid.2015.10.044

Molnar, J. A. (2025). Self-regulated Learning in an online asynchronous EFL classroom in Japan: What Strategies Do Students Use? *International Journal of TESOL Studies*, *7*(1), 48-69. https://doi.org/10.58304/ijts.20250104

Murray, D. W., & Rosanbalm, K. (2017). Promoting self-regulation in adolescents and young adults: A practice brief. OPRE Report 2015-82. *Office of Planning, Research and Evaluation*. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://files.eric.ed.gov/fulltext/ED594226.pdf

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education*, *31*(2), 199-218. https://doi.org/10.1080/03075070600572090

Nieminen, P., Hähkiöniemi, M., & Viiri, J. (2024). Forms and functions of on-the-fly formative assessment conversations in physics inquiry lessons. In *Developing Formative Assessment in STEM Classrooms* (pp. 18-40). Routledge. eBook ISBN: 9781003466079

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in Psychology*, *8*, 422. https://doi.org/10.3389/fpsyg.2017.00422

Pintrich, P. R. (2000). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *Journal of Educational Psychology*, *92*(3), 544. https://doi.org/10.1037/0022-0663.92.3.544

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. *Handbook of Self-Regulation/Academic*. https://doi.org/10.1016/B978-012109890-2/50043-3

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of educational psychology*, *82*(1), 33-40. DOI:10.1037/0022-0663.82.1.33

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and applications.* Merrill/Prentice Hall. https://lccn.loc.gov/95017192

Prompan, J., & Piamsai, C. (2024). The effects of peer feedback and self-regulated learning on Thai EFL students' writing ability and self-regulation. *LEARN Journal: Language Education and Acquisition Research Network*, *17*(1), 100-132. https://so04.tci-thaijo.org/index.php/LEARN/article/view/270378

Räisänen, M., Postareff, L., & Lindblom-Ylänne, S. (2016). University students' self-and co-regulation of learning and processes of understanding: A person-oriented approach. *Learning and Individual Differences*, *47*, 281-288. https://doi.org/10.1016/j.lindif.2016.01.006

Schunk, D. H., & Zimmerman, B. J. (Eds.). (2008). *Motivation and self-regulated learning: Theory, research, and applications*. Routledge. https://doi.org/10.4324/9780203831076

Stiggins, R., Arter, J., Chappuis, J., & Chappuis, S. (2007). *Classroom assessment for student learning: Doing it right - using it well.* Pearson. ISBN-13: 978-0132685887

Yosefi Afrashteh, M., Sayami, L., & Rezae, A. (2014). The relationship between classroom assessment methods and students' learning approaches and their preferences machinery. *Quarterly of Educational Measurement*, *5*(17), 125-148. https://doi.org/10.22054/jem.2015.331 (in Persian)

Yousefi Afrashteh, M., & Dehghani, Z. (2021). Relationship between teacher feedback and academic boredom and well-being: An analysis of the possible mediating role of task value. *Iranian Journal of Medical Education*, *21*(1), 502-511. URL: http://ijme.mui.ac.ir/article-1-5343-fa.html (in Persian)

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist*, *25*(1), 3-17. https://doi.org/10.1207/s15326985ep2501_2

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. *Self-regulation: Theory, research, and applications/Academic*. https://doi.org/10.1016/B978-012109890-2/50031-7

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice*, *41*(2), 64-70. https://doi.org/10.1207/s15430421tip4102_2

Zimmerman, B. J. (2012). Goal setting: A key proactive source of academic self-regulation. In *Motivation and self-regulated learning* (pp. 267-295). Routledge. url=https://api.semanticscholar.org/CorpusID:149780394

Yang, X. (2025). Linguistically responsive formative assessment for emergent bilinguals: exploration of an elementary teacher's practice in a math classroom. *International Multilingual Research Journal*, *19*(1), 67-90. https://doi.org/10.1080/19313152.2024.2339757