

The moderating role of task type between intrinsic motivation and math achievement: A study of individual exams and group assignments

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Abstract

This study examines the relationship between intrinsic motivation and achievement in mathematics. Specifically, motivation influences achievement in individual tests compared to group assignments. The study further investigates the moderating role of task type (individual vs. group-based assessments) in this relationship. A mixed-methods research design was employed, combining quantitative data from 45 pre-service teachers with qualitative insights from their open-ended responses. Statistical analyses, including correlation, regression, and moderation analyses, were conducted to examine these relationships. Results revealed a positive but non-significant correlation between intrinsic motivation and math achievement in group assignments ($r = 0.657$, $p = 0.095$), suggesting that while motivation may enhance achievement in collaborative tasks, other factors also contribute. Conversely, a negative correlation was found in individual tests ($r = -0.418$, $p = 0.053$), indicating that increased intrinsic motivation might lead to performance anxiety, which can undermine achievement. Regression analysis showed that motivation explained 12.7% variance in group achievement and 17.5% in individual performance, with the latter showing a marginally significant negative effect. Moderation analysis confirmed that the effect of intrinsic motivation on math achievement depends on task type. In individual tests, motivation had a significant negative impact on achievement ($\beta = -0.418$, $p = 0.035$), whereas in group assignments, the effect was positive but not statistically significant ($\beta = 0.657$, $p = 0.073$). Qualitative findings complemented these results by showing that students' task preferences were shaped by autonomy, collaboration, and workload distribution. These findings highlight the importance of considering task type when evaluating motivation's role in math achievement. Practical implications suggest that fostering intrinsic motivation through collaborative tasks can reduce performance anxiety, whereas individual assessments require supportive strategies to sustain motivation while minimizing stress. Future research should examine additional moderators and apply the model to larger, more diverse samples.

Keywords: math achievement, intrinsic motivation, individual exam, collaborative learning, group assignments

INTRODUCTION

Ongoing efforts to enhance student learning outcomes in mathematics have remained a major focus of educational research and practice (Fong-Yee & Normore, 2013; Koskinen & Pitkaniemi, 2022; Rabab'h & Veloo, 2015). In response, a myriad of innovative instructional strategies has been explored, with cooperative learning methods, particularly group work, receiving significant attention for their potential to improve academic achievement, develop foundational

skills, and foster positive learning environments (Jdaitawi et al., 2022a; Kovacheva et al., 2022; Li & Wang, 2024). Rooted in social constructivist theory, group work facilitates learning through social interaction, knowledge sharing, and the co-construction of understanding among peers. Empirical evidence suggests that these cooperative learning strategies are effective in enhancing student achievement in mathematics, reducing performance gaps, and fostering positive attitudes toward the subject (Chu et al., 2017;

Contribution to the literature

- This study highlights that the effect of intrinsic motivation on academic achievement depends critically on the type of assessment.
- In group assignments, the effect appears positive, while in individual tests, it becomes negative due to anxiety.
- The results provide an advanced model explaining when and why motivation matters, suggesting that assessments should be designed that emphasize group work while supporting individual assessments to mitigate stress.

Foldnes, 2016; Goodrich, 2018; Hwang & Chen, 2019; Li et al., 2023; Lim et al., 2023; Moreno-Guerrero et al., 2020).

Concurrently, intrinsic motivation is considered a crucial factor for academic success. It is associated with greater flexibility, deeper conceptual understanding, and enhanced creativity (Agwu & Nmadu, 2023; Siller & Ahmad, 2024). Literature suggests that the collaborative and interactive nature of group work can be a powerful catalyst for developing this intrinsic motivation, enhancing self-esteem, and strengthening academic attitudes among students (Abed et al., 2020; Almazroui, 2023; Siller & Ahmad, 2023; Ummah BK & Hamna, 2021).

However, while the independent benefits of group work on both achievement and motivation are well documented (Bawaneh & Alnamshan, 2023; Rabab'h & Veloo, 2014a), a crucial and nuanced idea remains insufficiently explored: the interaction between these variables under different task conditions. The type of task, whether an individual assessment such as a traditional test or a collaborative group task, may fundamentally alter how intrinsic motivation translates into academic achievement. Student motivation may manifest differently when working individually vs. working as part of an integrated team.

Therefore, this study seeks to go beyond demonstrating direct effects and instead examine the contextual role of task type. It aims to examine the moderating effect of individual vs. group assessments on the relationship between intrinsic motivation and achievement in mathematics. By addressing this gap, the study will provide a more sophisticated understanding of how pedagogical design can improve the relationship between students' intrinsic motivation and mathematics achievement. The results of this study will provide valuable insights for teachers and curriculum designers, assisting in the strategic implementation of group work and individual assignments to maximize student motivation and ultimately improve mathematics instruction.

LITERATURE REVIEW

Theoretical Background

In group work, learning is carried out through social interaction involving knowledge sharing and

construction among the participants (Jong, 2016, p. 195), with the advantages reaped based on the social constructivism theory (Fieber, 2019). In this regard, according to Bryant and Bates (2015, p. 17), the perspective of a social constructivist when it comes to learning is laid on the role and nature of interaction with others to challenge knowledge, improve connections with the current knowledge and develop novel ways to obtain complementary ideas. In social constructivism, learning benefits are contended to stem from the learners' social interaction with each other, which happens during group work and instructional activities entailing collaborative activities (Fieber, 2019). In Le et al.'s (2018) study, the authors referred to cooperative learning as a nuanced pedagogical approach that was developed to mimic peer interaction, boost collaborative efforts in order to achieve learning outcomes success. The relevant approach in cooperative learning mainly focuses on collaboration and making sure that every group member has the same opportunity to learning, in order to promote their self-confidence and self-efficacy, and consequently, enhance their motivation (Arnianto & Yasin, 2023; Tran et al., 2019). In addition to motivational perspectives, resilience has also been emphasized as a key psychological construct in sustaining students' engagement and achievement. Arafa (2024) demonstrated that resilience-building interventions significantly reduce academic procrastination and enhance learners' self-efficacy and well-being. This suggests that resilience, together with intrinsic motivation, provides a strong foundation for students' persistence in collaborative and individual learning contexts. Engagement in cooperative learning involves the combination of learners' efforts towards achieving a united goal, depending on such interdependence to provide emotional support and guidance to each other during the learning cycle (Arnianto & Yasin, 2023). Added to the above, the learning environments within which group work takes place is conducive towards achieving positive learning outcomes in that it enhances the achievement and motivation of students (Amianto & Yasin, 2023; Siller & Ahmad, 2024). Past studies reported on the significant effect of cooperative learning on the achievement and motivation of students during the learning process (e.g., Arnianto & Yasin, 2023; Siller & Ahmad, 2024).

Impact of Group Work on Students' Math Achievement

The effect of group work on the achievement of students has been examined in previous studies; to begin with, Nazeef et al. (2024) looked into such effect on the academic achievement of students and found that the group work approach led to enhanced performance and goals achievement of students. Along the same line, Siller and Ahmad's (2024) experimental study involving school students highlighted the effective enhancement of students when it comes to mathematics learning and their positive attitudes towards the subject. Also, in Uya's (2023) study, the author revealed that the engagement of students in group work positively affected their achievement compared to the students exposed to traditional, expository learning in mathematics. In addition, literature generally shows the role of group work in minimizing achievement gaps of students; for instance, group work interventions were found to be effective in lessening the achievement gap between students that are high achievers and low achievers in the mathematics subject (e.g., Lee & Boo, 2022). Similarly, group work interventions in elementary schools' mathematics education were effective in successfully minimizing achievement gaps, providing benefits to high achievers and low achievers equally (Kim & Son, 2023). Lastly, group work approach plays a role in enhancing the achievement and engagement of students in learning; for instance, Ahmad and Dogar (2023) revealed that group work exposed students in the experimental group performed better than their traditional learning exposed counterparts in mathematics subject. Also, group work has a positive impact on the learning outcomes and achievement among students.

Impact of Group Work on Students' Intrinsic Motivation

In education, motivation of learners is among the top aspects that need consideration (Arnianto & Yasin, 2023) and is a complex concept that is characterized with different dimensions, namely intrinsic and extrinsic motivation, which have a key role in forming learning experiences among students (Jdaitawi et al., 2022b; Santrock, 2008). Extrinsic motivation is described as motivation that is motivated by an external goal from oneself, whereas intrinsic motivation is described as motivated by an internal goal that drives an individual to perform based on enjoyment or interest (Ryan & Deci, 2000). In other words, a person who is intrinsically motivated performs a task because of the experienced enjoyment or because of the value placed on the same, which can be in the form of new concepts or skills learning (Fieber, 2019). In relation to this, intrinsically motivated learning display outstanding attributes that have a positive effect in their learning process (Arnianto & Yasin, 2023). Some attributes of which include

resilience in tackling learning challenges (Karlen et al., 2019), a comprehension of scientific concepts (Ng, 2018), greater creative expressions and overall academic achievement (Wu et al., 2020). Motivation of students in learning can be improved through competition and collaboration among each other (Liu, 2020; Rabab'h, 2023). Collaboration and cooperation among students lead to the development of intrinsic motivation and enhanced self-esteem, pair-working, pro-academic standards enhancement, and a sense of being a part of a specific learner group (Ning & Hornby, 2014). Moreover, according to Arnianto and Yasin (2023), positive motivation greatly contributes to cooperative learning initiative success.

Furthermore, cooperative learning also contributes to students' motivation and as such, it is considered as a positive teaching strategy that university students are generally exposed to (Cecchini et al., 2021; Liu & Lipowski, 2021; Mendo-Lazaro et al., 2022; Rabab'h & Veloo, 2014b; Tran et al., 2019; van Wyk, 2012). In this learning and teaching strategy, members of the group generate their motivation beliefs, attitudes and aspirations, and these play a key role in group activity achievement in the classroom (Järvelä et al., 2010; Rabab'h, 2015). Thus, group work increases the chances of group learning success (Jong, 2016).

Literature on group work comprises of diverse students in light of their contexts and they have provided many different advantages that can be reaped from the strategy and its effects on motivation among students. Among them, Arianto and Yasin's (2023), experimental study involving school students showed that cooperative learning significantly affects learning motivation in a positive direction. In the same study caliber, Naz et al. (2022) found group work to be effective in improving the learning and motivation of students, and Loes' (2022) study showed that approaches used in group work enhanced the motivation of students regardless of their race or ethnicity. Kasumi and Xhemaili (2023) revealed the effectiveness of group work in assisting students' motivation and Estrada et al. (2019) empirically found group work to enhance the students' motivation, intention, and peer interactions and relationships—their study involved the participation of 372 students. Generally, past studies' results support the benefits that group work provides and the efficacy it serves in the promotion and enhancement of learning motivation towards learning goal achievement. Therefore, this study specifically addresses the moderating role of task type (individual vs. group-based assessments) in influencing the relationship between intrinsic motivation and math achievement.

Impact of Intrinsic Motivation With Individual and Group Work and Student Learning

In the context of individual work, research indicates that when students are intrinsically motivated, they

demonstrate greater diligence, enhanced creativity, and a preference for challenging tasks. This is because the responsibility falls squarely on the student as they learn to satisfy their curiosity and mastery goals (Bawaneh et al., 2012; Inoue, 2007). According to self-determination theory (Ryan & Deci, 2000), this is facilitated by environments that support feelings of autonomy, competence, and relatedness. In individual settings, an intrinsically motivated student is more likely to go beyond traditional rote memorization and engage in deeper cognitive processing by connecting new information to existing knowledge structures, leading to more robust and sustainable learning outcomes.

The impact of intrinsic motivation becomes more complex when applied to group work. While the basic learning benefits remain, the social dynamics of the group can either fuel or undermine an individual's intrinsic motivation. Tanaka (2022) suggests that a well-structured collaborative task, aligned with students' interests, can have a powerful synergistic effect, as shared enthusiasm and cohesion within the group enhance individual motivation. Parmar et al. (2025) also suggest that groups can provide a supportive environment for achieving competence through peer support and feedback. However, studies also highlight significant risks. Social laxity, where some members withdraw, or coercive peer pressure can severely damage a student's sense of autonomy (Fudolin & Dioso, 2025; Javaid et al., 2025). Furthermore, if the group's focus is on the external reward of a grade (extrinsic motivation) or if conflict arises, an individual's intrinsic motivation may be replaced or eliminated. Therefore, the success of group work in promoting intrinsic motivation and deep learning depends largely on careful design, clear individual accountability, and the inculcation of positive group norms that protect each member's psychological needs for autonomy, competence, and communication (Francis et al., 2025; Gregory & Thorley, 2013).

Research Questions

1. Does intrinsic motivation significantly predict math achievement in individual assessments?
2. Does intrinsic motivation significantly predict math achievement in group assignments?
3. Does task type (individual vs. group) moderate the relationship between intrinsic motivation and math achievement?
4. What are students' preferences toward individual vs. group tasks, and what reasons do they provide for these preferences?

Limitation

This study is limited by its small sample size ($N = 45$), which affects the generalizability of the findings. While the model fit was acceptable, some absolute fit indices

were below the recommended thresholds, likely due to sample size constraints. Additionally, the measurement of math achievement was based on final exam scores and group assignments, which may not fully capture students' learning experiences. Future research should address these limitations by using larger samples, and alternative achievement measures.

METHODOLOGY

Research Design

This study employs a mixed-methods of research design, combining quantitative and qualitative approaches. The quantitative component involves using a Likert scale survey to measure participants' intrinsic motivation (25 items), while the qualitative component uses one open-ended question to gather detailed insights about their preferred method of completing tasks in their university courses, whether group-based or individual, along with the reasons for their preferences. A purposive sampling method was used to select participants who met specific criteria relevant to the study's objectives.

Research Population and Sample Study

The study population consists of pre-service teachers at the bachelor's level from the college of education at one of the Gulf Cooperation Council universities during the academic year 2023/2024. The total number of pre-service teachers is 300, including 210 (70%) females and 90 (30%) males studying at the college of education. The study sample consisted of 45 pre-service teachers from the college of education, with 14 males (31%) and 31 females (69%).

Instruments

In this study, the questionnaire was developed by adapting items from prior studies that have been validated, data for the study were collected through a questionnaire divided into three sections, using a total of 25 items to assess the intrinsic motivation of pre-service teachers regarding teamwork in task performance. These sections include interpersonal enjoyment (8 items), value usefulness (9 items) and perceived choice (8 items).

Data Collection Procedure

The survey was administered in a session during class time for the participating students to ensure a response and a controlled environment. Prior to distribution, the purpose of the study was briefly explained, emphasizing voluntary participation and anonymity. The questionnaires were shared with participants by using google form, participants were given clear instructions on how to complete the survey, which included the 25 quantitative items measured on a five-point Likert scale (from strongly agree =5, to strongly disagree =1) and the final open-ended

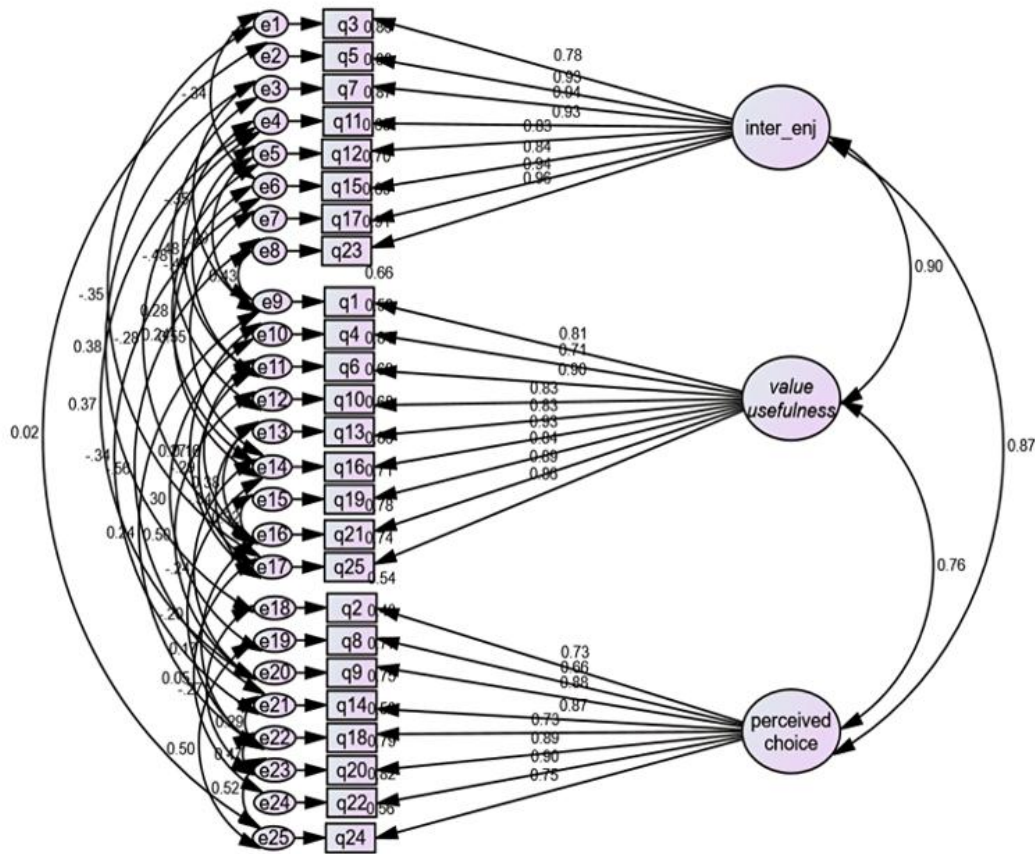


Figure 1. CFA model for the motivation scale using AMOS V.23 (Source: Authors' own elaboration, using AMOS V.23)

qualitative question. The administration occurred in the middle of the academic year 2023/2024, ensuring that students had sufficient experience with both individual and group assignments to provide informed responses. Ample time was provided for all participants to finish.

The results of the mathematics course were obtained by the participating students during the first semester (February 2024). The students' results in the final exam were recorded, in addition to their results in group assignments during the semester.

Data collected was analyzed with the help of statistical package for social sciences version 26 (SPSS v.26), to examine the obtained information from the respondents.

Reliability Analysis

The scale demonstrated high internal consistency, with Cronbach's alpha coefficients ranging between 0.80 and 0.95 across three dimensions: interpersonal enjoyment, value usefulness, and perceived choice. These values indicate strong reliability and internal coherence of the scale items.

Validity Analysis

The confirmatory factor analysis (CFA) was conducted using structural equation modeling in AMOS V.23 to evaluate the factorial structure and construct validity of the motivation scale, which consists of three

factors: interpersonal enjoyment, value usefulness, and perceived choice.

Figure 1 illustrates the structural relationships between the latent constructs and their observed items, clearly representing how each item aligns with its respective factor. **Table 1** provides detailed CFA results, including factor loadings, estimates, standard errors (SE), critical ratios (CR), and p-values. Factor loadings across all items were strong and statistically significant ($p < .001$), indicating robust associations between observed items and their latent factors. Specifically, the interpersonal enjoyment factor showed high loadings from 0.781 to 0.956 (e.g., item q23: 0.956). Value usefulness items also displayed strong loadings between 0.707 (q4) and 0.926 (q16), while perceived choice exhibited slightly more variability, ranging from 0.657 (q8) to 0.905 (q22).

Regarding overall model fit, CFA indicated acceptable indices ($\chi^2 = 367.999$, $df = 237$, $p < .001$; $CMIN/df = 1.553$). Incremental indices also demonstrated acceptable fit ($CFI = 0.915$; $IFI = 0.918$), although TLI (0.892) was slightly below the preferred threshold. $RMSEA$ (0.068) indicated an acceptable fit (< 0.08). However, absolute fit indices such as GFI (0.686) and $AGFI$ (0.569) were below optimal criteria, possibly influenced by the relatively small sample size ($N = 45$).

Table 1. CFA results showing the factor loadings and statistical significance for each item

Item	Factor	Estimate	SE	CR	p	Factor loading
q3	Interpersonal enjoyment (inter_enj)	1.000				.781
q5	Interpersonal enjoyment (inter_enj)	1.363	0.183	7.454	< .001	.928
q7	Interpersonal enjoyment (inter_enj)	1.318	0.171	7.726	< .001	.941
q11	Interpersonal enjoyment (inter_enj)	1.161	0.153	7.573	< .001	.933
q12	Interpersonal enjoyment (inter_enj)	1.306	0.202	6.472	< .001	.828
q15	Interpersonal enjoyment (inter_enj)	1.144	0.205	5.588	< .001	.836
q17	Interpersonal enjoyment (inter_enj)	1.144	0.150	7.616	< .001	.941
q23	Interpersonal enjoyment (inter_enj)	1.288	0.164	7.837	< .001	.956
q1	Value usefulness (value_usefulness)	1.000				.813
q4	Value usefulness (value_usefulness)	0.967	0.174	5.547	< .001	.707
q6	Value usefulness (value_usefulness)	0.989	0.124	7.954	< .001	.899
q10	Value usefulness (value_usefulness)	1.03	0.147	6.997	< .001	.829
q13	Value usefulness (value_usefulness)	0.978	0.141	6.911	< .001	.825
q16	Value usefulness (value_usefulness)	1.132	0.125	9.073	< .001	.926
q19	Value usefulness (value_usefulness)	0.823	0.115	7.180	< .001	.843
q21	Value usefulness (value_usefulness)	0.911	0.118	7.708	< .001	.886
q25	Value usefulness (value_usefulness)	0.976	0.131	7.463	< .001	.860
q2	Perceived choice (perceived_choice)	1.000				.733
q8	Perceived choice (perceived_choice)	1.078	0.239	4.508	< .001	.657
q9	Perceived choice (perceived_choice)	1.221	0.196	6.234	< .001	.880
q14	Perceived choice (perceived_choice)	1.384	0.229	6.038	< .001	.868
q18	Perceived choice (perceived_choice)	1.228	0.245	5.021	< .001	.725
q20	Perceived choice (perceived_choice)	1.576	0.282	5.586	< .001	.890
q22	Perceived choice (perceived_choice)	1.270	0.201	6.329	< .001	.905
q24	Perceived choice (perceived_choice)	1.328	0.259	5.131	< .001	.750

Note. All items have high and significant loadings, confirming strong construct validity

Table 2. Pearson correlation between intrinsic motivation and math achievement in individual and group assessment contexts (SPSS v.26)

Group	Variable 1	Variable 2	Correlation (r)	p-value
Group	Motivation	Math achievement	0.657	.095
Individual	Motivation	Math achievement	-0.418	.053

Despite these limitations, the combined evidence from **Figure 1**, **Table 1**, and the discussed model fit indices strongly supports the factorial validity, internal consistency, and overall reliability of the motivation scale. Future research with larger and more diverse samples is recommended to confirm and further strengthen these findings.

RESULTS

Quantitative Results

Hypothesis 1. To investigate if there is a significant difference in the relationship between motivation and math achievement across individual and group educational settings.

The result in **Table 2** reveals contrasting relationships between motivation and math achievement in group vs. individual settings, emphasizing the role of context in shaping these dynamics. In group settings, motivation shows a modest positive but non-significant correlation with math achievement ($r = 0.657$, $p = 0.095$), suggesting that higher motivation may slightly enhance performance, potentially due to supportive group

dynamics and shared goals. In contrast, within individual settings, motivation exhibits a negative correlation ($r = -0.418$, $p = .053$), approaching significance, indicating that higher motivation may correlate with lower achievement, possibly due to increased stress or pressure in solitary contexts. These findings highlight the differential impact of motivation, with group environments potentially fostering positive outcomes through collaboration, while individual settings may amplify psychological pressures, undermining performance. This underscores the need for context-specific motivational strategies, recognizing that the social environment significantly moderates the relationship between motivation and academic achievement.

Hypothesis 2. To determine if motivation significantly predicts math achievement across different educational contexts (individual vs. group).

The regression analysis presented in **Table 3** and **Table 4** demonstrates distinct patterns regarding how motivation predicts math achievement across individual and group contexts. In group settings, motivation explained approximately 12.7% of the variance in math

Table 3. Regression analysis of motivation predicting math achievement in individual and group assessment contexts (SPSS v.26)

Group	Model	R	R ²	Adjusted R ²	SE of the estimate
Group	1	.657 ^a	.127	.086	4.27039
Individual	1	.418 ^a	.175	.134	16.22420

Note. ^aPredictors: (Constant), motivation

Table 4. Results of linear regression analyses (SPSS v.26)

Group	Model	Unstandardized coefficients		Standardized coefficients	t	Significance
		B	SE	Beta		
Group	1	(Constant)	86.269	4.048		21.313
		Motivation	.070	.040	.657	1.751
Individual	1	(Constant)	109.862	16.703		6.577
		Motivation	-.377	.183	-.418	-2.059

Note. Dependent variable: Math achievement

Table 5. Multigroup moderation analysis of motivation and math achievement by educational context (individual vs. group) (AMOS v.23)

Context	Path	Unstandardized coefficient (B)	SE	t-value	p-value	Beta
Individual	Motivation → math achievement	-0.377	0.179	-2.111	0.035*	-0.418
Group	Motivation → math achievement	0.070	0.039	1.791	0.073	0.657

Note. * $p < 0.5$

achievement ($R^2 = 0.127$, adjusted $R^2 = 0.086$), reflecting a modest but non-significant positive predictive relationship ($p = 0.095$). The relatively low explained variance and moderate SE (4.27) suggest additional influencing factors beyond motivation may affect performance in group assessments. The regression coefficient ($B = 0.070$, $\beta = 0.65$) indicates a weak, positive but non-significant predictive relationship. This suggests limited predictive power and highlights that other variables might contribute significantly to math achievement in collaborative contexts.

Conversely, within individual assessment contexts, motivation accounted for 17.5% of the variance in math achievement ($R^2 = 0.175$, adjusted $R^2 = 0.134$). Here, motivation displayed a marginally significant negative predictive relationship ($B = -0.377$, $\beta = -0.418$, $p = 0.053$), accompanied by a larger SE (16.22), reflecting greater variability in performance. This negative relationship suggests that higher intrinsic motivation might introduce additional psychological pressures or stress in individual assessment situations, potentially impairing student performance.

Overall, these findings underscore the critical role contextual factors play in moderating motivation's impact on math achievement. Specifically, while group contexts might foster supportive dynamics that slightly enhance performance, individual contexts could heighten stress, adversely affecting achievement outcomes. This underscores the importance of considering social and contextual factors in understanding the role of motivation in academic performance.

Hypothesis 3. To determine whether the educational context (individual vs. group) significantly moderates

the relationship between motivation and math achievement among students.

The results of the multi-group moderation analysis (Table 5) indicate that the effect of motivation on math achievement differs significantly between individual and group settings. For the individual context, the path coefficient ($\beta = -0.418$) is negative and statistically significant ($p = 0.035$), indicating an inverse relationship between motivation and math achievement. This suggests that in individual contexts, increased motivation may be associated with lower math achievement, potentially due to factors such as pressure or stress.

In contrast, within the group context, the path coefficient is positive but not statistically significant ($\beta = 0.657$, $p = 0.073$). Although the positive direction suggests a beneficial impact of motivation in group environments, the non-significant result implies that this relationship may be influenced by additional moderating variables or greater variability in group dynamics, indicating that motivation alone may not directly enhance math achievement in group settings.

Further insights are provided pairwise parameter comparisons between the two groups. Specifically, the CR comparing the individual and group parameters is 2.444, exceeding the threshold of 1.96 required for statistical significance. This confirms a significant moderation effect, demonstrating that motivational influences differ significantly between individual and group assessment contexts. These findings underscore the crucial role of contextual factors in shaping motivational effects on educational outcomes. While individual contexts may intensify stress or pressure, thereby negatively influencing math achievement,

Table 6. Distribution of students' preferences

Preference category	Frequency (N)	Percentage (%)
Individual work preference	24	53.33
Group work preference	19	42.22
Neutral/context-dependent	2	4.45
Total	45	100

group contexts could mitigate this stress through social support or collaborative dynamics. Overall, these results highlight the importance for educators and researchers to carefully consider contextual influences when designing interventions aimed at fostering student motivation and improving academic performance.

Qualitative Results

To analyze qualitative data (students' open-ended responses regarding their preference for performing tasks individually or in groups), R qualitative data analysis software was utilized for systematic qualitative coding, categorization, and thematic analysis. Students' responses were categorized into three themes: individual preference, group preference, and neutral or context-dependent preference as shown in **Table 6**.

Individual work preference

Students prefer individual tasks to emphasize autonomy, flexibility in time management, and enhanced work quality.

Illustrative examples from student responses:

"I prefer individual work if the workload is small, but group work if the project is large."

"Individual work allows better personal time management and avoids coordinating with other group members. I feel my achievement and skills improve significantly when working individually."

Group work preference

Students who favored group work highlighted benefits such as collaboration, creativity, sharing ideas, and enjoyment when working with suitable group members.

Illustrative examples from student responses:

"Group work allows exchanging experiences, ideas, and reduces the workload, which helps in achieving tasks faster and with higher quality."

"Group work is beneficial and enjoyable, especially when working with the right team members."

Neutral or context-dependent preference

Some students expressed their preference conditionally based on task nature, workload, and group dynamics.

Illustrative examples from student responses:

"It depends on the task or assignment."

"Each method has advantages and disadvantages, but generally, I prefer group tasks if the group members share my goals and ambitions. Otherwise, individual tasks are more suitable."

Beyond the three main categories, the qualitative coding revealed sub-themes that deepen the understanding of students' preferences. For individual work, responses reflected concerns with time management, autonomy and independence, and perceived higher quality of output. Group work preferences were further explained by idea-sharing and creativity, workload distribution, and enjoyment and motivation. Neutral or context-dependent responses were shaped by the nature of the assignment and the composition of group members. These sub-themes enrich the qualitative findings and align with the quantitative results, providing stronger evidence that task type influences how intrinsic motivation interacts with students' achievement.

DISCUSSION

This study's findings align with existing literature emphasizing the transformative impact of group work on students' math achievement. The effectiveness of group work, as highlighted in studies by Nazeef et al. (2024) and Siller and Ahmad (2024), demonstrates significant improvements in students' achievement and attitudes towards mathematics. This is particularly evident in how group work not only enhances achievement but also minimizes the achievement gaps between high and low achievers, a finding supported by Lee and Boo (2022) and Kim and Son (2023). The mechanism behind these benefits is rooted in the shared resources and collective problem-solving that define group work environments, fostering a richer and more engaging learning experience that encourages deeper understanding and retention of mathematical concepts.

The qualitative findings complement and further explain the quantitative results by highlighting students' reasoning behind their task-type preferences. Students preferring individual work cited factors such as

autonomy and stress management, aligning with quantitative findings that high intrinsic motivation might lead to increased stress and reduced performance in individual contexts. Conversely, students favoring group tasks emphasized collaborative benefits like idea-sharing and reduced workload pressures, resonating with quantitative evidence of a positive (though non-significant) relationship between motivation and achievement in collaborative settings. Thus, both qualitative and quantitative analyses converge to illustrate the critical role context plays in determining motivational impacts.

Group Work's Impact on Intrinsic Motivation

The study further illustrates the role of group work in enhancing intrinsic motivation among students, an aspect critically underscored by Arnianto and Yasin (2023). Intrinsic motivation, driven by an internal desire to engage in learning due to genuine interest or enjoyment, as described by Ryan and Deci (2000), is significantly fostered through collaborative settings. These settings provide a platform for social interaction and knowledge construction, which are fundamental in satisfying the psychological needs for autonomy, competence, and relatedness which represent key components of self-determination theory (Fieber, 2019). As students engage in collaborative tasks, they experience a sense of belonging and accomplishment, which not only enhances their motivation but also contributes to more resilient learning behaviors and improved math achievement.

Practical Implications and Recommendations

These findings have critical implications for educators and curriculum designers. Integrating group work strategies into math education can create more engaged, motivated learners and potentially reduce achievement disparities. Educators are encouraged to facilitate group activities promoting equal participation and equitable access to resources, thus improving math achievement, developing social skills, and preparing students for collaborative modern work environments.

While the current findings strongly support the benefits of group work, further research is recommended to examine its long-term impacts and applicability across various educational settings and diverse student populations. Future studies could explore specific group work components that are most effective in enhancing math achievement and motivation, and how these strategies can be tailored for students with diverse learning preferences and backgrounds. In conclusion, group work represents a powerful pedagogical approach, significantly enhancing math achievement, bridging achievement gaps, and boosting intrinsic motivation. Educational systems should therefore incorporate cooperative learning

opportunities into curricula, fostering intellectually stimulating and emotionally supportive learning environments.

CONCLUSION

This study examined the moderating role of task type (individual exams vs. group assignments) in the relationship between intrinsic motivation and math achievement among pre-service teachers. The results indicated that intrinsic motivation negatively and significantly predicted math achievement in individual exam contexts, whereas it had a positive but non-significant influence in group project settings. Additionally, qualitative results reinforced these findings, demonstrating students' preferences were context-dependent and aligned with quantitative outcomes. These findings underscore the critical importance of considering task type as a moderator, suggesting educators should adopt differentiated motivational strategies tailored to assessment contexts to optimize student achievement and motivation. Furthermore, this research uniquely contributes to existing literature by explicitly exploring task type as a moderator in the relationship between intrinsic motivation and math achievement. Prior research typically examined these variables separately or within single assessment contexts. By directly comparing individual and collaborative tasks, this study clarifies how the assessment type can alter motivational effects on student performance. Such insights not only address an existing research gap but also provide valuable practical implications for educators aiming to enhance motivation and achievement through appropriate instructional design and assessment strategies.

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AI statement: The authors stated that the generative AI tools were used to check the clarity of English for some paragraphs only. The AI did not perform any content generation.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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APPENDIX A

Table A1. Intrinsic motivation survey

No	Item
1	I believe that doing this task within a group could be valuable for me.
2	I believe I had some choice in doing this task.
3	While I was doing the group work, I was thinking about how much I was enjoying it.
4	I believe that working within a group is useful for improving concentration.
5	Working within the group was enjoyable.
6	I believe that performing tasks within a group is important for my development.
7	I very much enjoyed doing this group task.
8	I didn't really have a choice to do this group task.
9	I did this group task because I wanted to.
10	I believe that this work within a group is important.
11	I felt as if I was enjoying the group work while I was doing it.
12	I thought the group work was very boring.
13	Group work could potentially improve my study habits.
14	I felt that I had no choice but to do this group work.
15	I find group work very interesting.
16	I am willing to do the group work again because I believe it is somewhat useful.
17	I would describe this work as very enjoyable.
18	I felt compelled to do this work.
19	I believe that doing the work within a group could be somewhat beneficial for me.
20	I did this work in a group because I was forced to.
21	I believe that working within a group can help me improve my performance in school.
22	While doing the group work, I felt that I had a choice.
23	I would describe the group work as very enjoyable.
24	I felt that it was not my choice to do the work within a group.
25	I would be willing to do the group work again because it holds some value for me.

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