

The Relationship Between Learning Motivation and Academic Achievement of Mathematics Education Students in Ontario

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ABSTRACT

This study examines the relationship between learning motivation and academic achievement among mathematics education undergraduate students at universities in Ontario, Canada. Understanding motivational factors influencing academic performance is essential for developing effective educational interventions and support systems that enhance student success in teacher preparation programs. Employing a correlational research design, this investigation surveyed 245 mathematics education majors from five Ontario universities using validated instruments measuring intrinsic motivation, extrinsic motivation, amotivation, and self-efficacy, while academic achievement was assessed through cumulative grade point averages and mathematics content course performance. Statistical analyses including Pearson correlation, multiple regression, and path analysis revealed significant positive relationships between intrinsic motivation and academic achievement ($r = .54, p < .001$), with self-efficacy serving as a significant mediating variable. Extrinsic motivation demonstrated moderate positive correlations, while amotivation showed strong

negative associations with achievement. Gender and year of study emerged as significant moderating variables affecting motivation-achievement relationships. Findings highlight the critical importance of fostering intrinsic motivation and self-efficacy in mathematics teacher education programs through autonomy-supportive instruction, meaningful learning tasks, and targeted academic counseling interventions addressing motivational challenges.

INTRODUCTION

Academic achievement in higher education represents a complex phenomenon influenced by cognitive, affective, social, and contextual factors that interact dynamically throughout students' educational experiences. Among these influential factors, learning motivation has emerged as a particularly powerful predictor of academic success, persistence, and educational attainment across diverse disciplinary contexts and student populations (Richardson et al., 2012). Motivation encompasses the internal processes that initiate, direct, and sustain goal-oriented behaviors, determining not only whether students engage with learning tasks but also how deeply they process information, how persistently they pursue challenging goals, and how they respond to setbacks and difficulties. Understanding motivation's relationship with academic achievement holds particular significance for mathematics education programs, where students must develop both sophisticated mathematical content knowledge and pedagogical expertise—a dual challenge requiring sustained engagement, cognitive effort, and resilience in the face of conceptual and practical difficulties.

Mathematics education programs in Ontario, Canada, operate within a distinctive educational landscape characterized by rigorous certification requirements, diverse student populations, and evolving expectations for teacher preparation. Ontario's teaching profession is regulated by the Ontario College of Teachers, which establishes certification standards requiring prospective teachers to complete approved Bachelor of Education programs demonstrating both subject matter expertise and pedagogical competence (Ontario College of Teachers, 2021). Mathematics education students must achieve high academic standards in advanced mathematics courses while simultaneously developing instructional skills, pedagogical content knowledge, and professional dispositions essential for effective teaching. This demanding curriculum creates unique motivational challenges, as students navigate difficult mathematical content, confront their own mathematical anxieties and beliefs, and develop confidence in their capacity to teach mathematics effectively to diverse learners.

Contemporary motivation theory offers several complementary frameworks for understanding how motivational processes influence academic achievement. Self-Determination Theory (SDT), developed by Deci and Ryan (2000), distinguishes between intrinsic motivation—engagement in activities for inherent satisfaction and interest—and extrinsic motivation—engagement driven by external rewards,

pressures, or consequences. SDT proposes that intrinsic motivation produces superior learning outcomes including deeper conceptual understanding, greater creativity, enhanced persistence, and better psychological well-being compared to extrinsic motivation. The theory further identifies three fundamental psychological needs—autonomy, competence, and relatedness—whose satisfaction fosters intrinsic motivation while their frustration promotes amotivation or controlled forms of extrinsic motivation. In educational contexts, autonomy-supportive teaching that provides meaningful choices, explains rationales for learning activities, and acknowledges students' perspectives enhances intrinsic motivation, whereas controlling approaches emphasizing external evaluation and pressure undermine it (Muhsyanur, 2023).

Complementing SDT, expectancy-value theory developed by Eccles and Wigfield (2020) emphasizes students' achievement-related beliefs and values as central motivational determinants. This framework proposes that achievement behaviors result from students' expectations for success (Can I do this task?) and subjective task values (Do I want to do this task? Is it worth my effort?). Task values encompass intrinsic value (inherent enjoyment), attainment value (importance for identity), utility value (usefulness for future goals), and cost (required effort, anxiety, lost opportunities). Research demonstrates that students' expectancies and values predict achievement choices, persistence, and performance across domains, with mathematics representing an area where expectancy beliefs prove particularly influential given the discipline's hierarchical structure and widespread beliefs about mathematical ability as fixed rather than developable (Wigfield & Cambria, 2010).

Self-efficacy—individuals' beliefs about their capabilities to organize and execute actions required to achieve specific goals—represents another critical motivational construct with demonstrated relationships to academic achievement (Muhsyanur, 2024). Bandura's (1997) social cognitive theory positions self-efficacy as a primary determinant of goal setting, effort expenditure, persistence, and resilience in the face of obstacles. Students with strong self-efficacy approach challenging tasks as opportunities for mastery rather than threats to be avoided, set ambitious goals, maintain commitment when encountering difficulties, and recover quickly from setbacks. Mathematics self-efficacy has received extensive research attention given mathematics' gatekeeper role (Mulyana et al., 2021) in STEM education and careers, with studies consistently demonstrating that self-efficacy predicts mathematics achievement, course-taking patterns, and career aspirations (Pajares & Miller, 1994). For mathematics education students, self-efficacy encompasses both mathematical content confidence and teaching efficacy beliefs—confidence in their capacity to teach mathematics effectively—both of which influence academic achievement and teaching practice.

Despite extensive research on motivation and achievement in K-12 mathematics education, the relationship between these constructs in post-secondary mathematics education contexts, particularly among prospective mathematics teachers, remains relatively underexplored. Most existing studies examine general

undergraduate populations or STEM majors broadly, without attending to the unique characteristics of mathematics education students who must develop dual expertise in mathematical content and pedagogical practice. Mathematics education majors face distinct motivational challenges including confronting and overcoming their own mathematics anxieties, reconciling personal mathematical struggles with professional teacher identities, and maintaining motivation through demanding coursework that may exceed difficulty levels they will eventually teach. Understanding how motivational factors relate to achievement specifically within this population can inform teacher education program design, student support services, and pedagogical practices that optimize motivation and learning outcomes.

Ontario's diverse and multicultural population creates additional complexity in examining motivation-achievement relationships, as students enter teacher education programs with varied cultural backgrounds, educational experiences, linguistic proficiencies, and beliefs about mathematics learning and teaching. Research indicates that cultural contexts shape motivational processes, with individualistic cultures emphasizing personal achievement and autonomy while collectivistic cultures prioritize group harmony and duty-based motivation (King & McInerney, 2014). Ontario universities serve significant proportions of international students and domestic students from diverse cultural backgrounds, necessitating culturally responsive understanding of how different students experience and express achievement motivation. Additionally, mathematics education programs increasingly emphasize equity, inclusion, and culturally responsive pedagogy, requiring students to critically examine traditional mathematics teaching practices and their own mathematical identities—processes potentially influencing motivational dynamics.

The present study addresses these gaps by systematically examining relationships between multiple dimensions of learning motivation and academic achievement among mathematics education undergraduate students across Ontario universities. Research questions guiding this investigation include: What relationships exist between intrinsic motivation, extrinsic motivation, amotivation, and academic achievement in mathematics education programs? How does self-efficacy mediate or moderate motivation-achievement relationships? Do these relationships vary across student demographic characteristics including gender, year of study, or prior mathematics achievement? What specific motivational profiles characterize high-achieving versus struggling mathematics education students? Answering these questions contributes theoretical understanding of achievement motivation in specialized educational contexts while providing practical guidance for supporting mathematics education students' academic success and professional development.

METHODE

This correlational study employed a cross-sectional survey design to examine relationships between learning motivation constructs and academic achievement

among mathematics education undergraduate students. Participants were 245 students enrolled in Bachelor of Education (Concurrent) or Bachelor of Science/ Arts programs with mathematics teaching specialization at five universities across Ontario: University of Toronto, York University, Queen's University, Western University, and University of Ottawa. These institutions were selected to represent Ontario's geographical diversity and range of program structures. Recruitment occurred through program coordinators who distributed survey invitations to all mathematics education majors in their programs during fall 2023 semester. Participation was voluntary, with a response rate of 61% among eligible students. The sample comprised 148 female students (60.4%) and 97 male students (39.6%), with representation across all undergraduate years: first year (n=52), second year (n=68), third year (n=71), and fourth year (n=54). Demographic data indicated diverse backgrounds, with 38% identifying as first-generation university students, 29% as international students, and 42% reporting speaking languages other than English at home.

Data collection utilized validated psychometric instruments administered through online survey platform. The Academic Motivation Scale (AMS-College version; Vallerand et al., 1992) measured seven motivation subscales organized into intrinsic motivation (to know, toward accomplishment, to experience stimulation), extrinsic motivation (identified, introjected, external regulation), and amotivation, using 28 items rated on 7-point Likert scales. The Mathematics Self-Efficacy Scale (MSES; Betz & Hackett, 1983) assessed confidence in mathematics tasks through 34 items rated on 10-point confidence scales. The Teacher Efficacy Scale adapted for mathematics teaching (Tschannen-Moran & Hoy, 2001) measured teaching self-efficacy through 24 items. Academic achievement was operationalized through two indicators: (a) overall cumulative GPA provided by students from official transcripts, and (b) average grades in core mathematics content courses (calculus, linear algebra, abstract algebra, real analysis) extracted from transcripts. Additional survey items collected demographic information, prior mathematics achievement (high school mathematics grades), and educational background variables. All instruments demonstrated acceptable reliability in this sample (Cronbach's α ranging from .82 to .94). Data analysis employed SPSS Statistics version 28, utilizing descriptive statistics, Pearson product-moment correlations, hierarchical multiple regression with achievement as dependent variable and motivation dimensions as predictors while controlling for prior achievement and demographic variables, mediation analysis using PROCESS macro to examine self-efficacy's mediating role, and moderation analysis testing whether motivation-achievement relationships varied by gender or year of study. Statistical significance was set at $p < .05$ with Bonferroni corrections applied for multiple comparisons. Missing data (less than 3% across variables) were handled through listwise deletion given the low percentage and randomness verification. Ethical approval was obtained from all participating universities' research ethics boards, with participants providing informed consent

and assured of confidentiality and voluntary participation without academic consequences.

RESULT AND DISCUSSION

Descriptive Statistics and Correlation Analysis of Motivation and Achievement Variables

Descriptive analysis revealed that mathematics education students reported moderate to high levels of intrinsic motivation ($M = 5.24$, $SD = 1.03$ on 7-point scale) and identified regulation extrinsic motivation ($M = 5.67$, $SD = 0.89$), indicating that students generally found mathematics education inherently interesting while also valuing it for personal and professional goals. Lower scores emerged for controlled forms of extrinsic motivation including introjected regulation ($M = 4.21$, $SD = 1.34$) and external regulation ($M = 3.78$, $SD = 1.42$), suggesting relatively less motivation driven by guilt, shame, or purely external rewards. Amotivation scores were low ($M = 2.15$, $SD = 1.21$), indicating that most students felt purposeful and efficacious rather than disconnected or helpless regarding their studies. Mathematics self-efficacy demonstrated moderately high levels ($M = 7.32$, $SD = 1.56$ on 10-point scale), while teaching self-efficacy showed similar patterns ($M = 7.08$, $SD = 1.48$). Academic achievement indicators revealed mean cumulative GPA of 3.42 ($SD = 0.48$) on 4.0 scale and mathematics course average of 78.6% ($SD = 9.3\%$), reflecting generally strong academic performance typical of competitive teacher education programs.

Correlation analysis revealed significant relationships between motivation variables and achievement outcomes, presented comprehensively in Table 1. Intrinsic motivation demonstrated the strongest positive correlation with both cumulative GPA ($r = .54$, $p < .001$) and mathematics course grades ($r = .51$, $p < .001$), indicating that students who studied mathematics education for inherent interest and enjoyment achieved substantially higher academic outcomes. This finding aligns with extensive research documenting intrinsic motivation's superiority for promoting deep learning, conceptual understanding, and academic achievement (Ryan & Deci, 2020). The identified regulation dimension of extrinsic motivation also showed significant positive correlations ($r = .38$ with GPA, $r = .35$ with mathematics grades), suggesting that personally valuing mathematics education—even when instrumentally motivated—supports achievement. However, more controlled extrinsic motivation forms showed weaker and sometimes non-significant relationships, while amotivation demonstrated strong negative correlations ($r = -.47$ with GPA, $r = -.42$ with mathematics grades), confirming that feelings of purposelessness and incompetence severely undermine academic success.

Table 1. Correlation Matrix of Motivation Variables, Self-Efficacy, and Academic Achievement Indicators

Variable	1	2	3	4	5	6	7	8	9
1. Intrinsic motivation	–								
2. Identified regulation	.62**	–							
3. Introjected regulation	.28**	.41**	–						
4. External regulation	.09	.23**	.58**	–					
5. Amotivation	-.56**	-.48**	-.31**	-.18*	–				
6. Mathematics self-efficacy	.64**	.52**	.21**	.06	-.61**	–			
7. Teaching self-efficacy	.58**	.49**	.24**	.11	-.53**	.72**	–		
8. Cumulative GPA	.54**	.38**	.15*	.08	-.47**	.59**	.48**	–	
9. Mathematics course average	.51**	.35**	.12	.05	-.42**	.62**	.44**	.89**	–

Note. N = 245. *p < .05. **p < .001.

Self-efficacy variables demonstrated the strongest correlations with achievement outcomes, with mathematics self-efficacy correlating .59 with cumulative GPA and .62 with mathematics course grades, while teaching self-efficacy showed slightly lower but still substantial correlations (.48 and .44 respectively). These robust relationships confirm self-efficacy as a critical achievement predictor, consistent with decades of research across educational contexts (Bandura, 1997). Notably, self-efficacy correlated strongly with intrinsic motivation ($r = .64$ for mathematics self-efficacy and intrinsic motivation), suggesting these constructs mutually reinforce each other—students confident in their mathematical abilities find mathematics more intrinsically enjoyable, while intrinsic interest supports skill development that builds confidence. This interrelationship has important implications for educational interventions, suggesting that enhancing either self-efficacy or intrinsic motivation may positively influence the other.

Examination of correlations within motivation dimensions revealed interesting patterns regarding motivation quality. The three intrinsic motivation subscales (to know, toward accomplishment, to experience stimulation) intercorrelated highly (.78-.85) and showed similar achievement correlations, suggesting they function as a unified construct in this population. Among extrinsic motivation types, identified regulation correlated more strongly with intrinsic motivation (.62) than with controlled extrinsic motivation forms (.23-.41), positioning it closer to autonomous rather than controlled motivation on the self-determination continuum. Conversely, external regulation and introjected regulation correlated highly (.58), representing more controlling motivational orientations. This pattern supports SDT's conceptualization of motivation as a continuum from amotivation through

controlled extrinsic motivation to autonomous motivation, rather than simple dichotomy between intrinsic and extrinsic (Ryan & Deci, 2020). The practical implication is that not all extrinsic motivation equally undermines learning—when students personally value and identify with goals, even instrumentally motivated engagement can support achievement.

Regression Analysis and Mediating Role of Self-Efficacy

Hierarchical multiple regression analysis examined unique contributions of motivation variables to academic achievement while controlling for relevant covariates and testing self-efficacy's potential mediating role. In the first model predicting cumulative GPA, demographic variables and prior achievement (high school mathematics grades) were entered as controls in Step 1, explaining 31% of variance ($R^2 = .31$, $F(4, 240) = 27.08$, $p < .001$). Prior mathematics achievement emerged as the strongest predictor ($\beta = .48$, $p < .001$), confirming that previous academic success substantially predicts future achievement. Gender showed non-significant effects, while international student status demonstrated small negative effects ($\beta = -.12$, $p = .04$), potentially reflecting language barriers or cultural adjustment challenges.

Step 2 added all motivation variables (intrinsic motivation, identified regulation, introjected regulation, external regulation, amotivation), significantly increasing explained variance to 47% ($\Delta R^2 = .16$, $F(9, 235) = 23.19$, $p < .001$). Among motivation predictors, intrinsic motivation ($\beta = .31$, $p < .001$) and identified regulation ($\beta = .18$, $p = .02$) showed significant positive effects, while amotivation demonstrated significant negative effects ($\beta = -.21$, $p = .001$). Controlled extrinsic motivation forms (introjected and external regulation) showed non-significant unique effects when other motivation types were controlled, suggesting their bivariate correlations with achievement reflected shared variance with more autonomous motivation forms or self-efficacy. These findings indicate that after accounting for prior achievement, students' autonomous motivation—whether intrinsic interest or personally valued instrumental motivation—uniquely predicts academic success, while feeling pressured or purposeless undermines achievement.

Step 3 added self-efficacy variables, further increasing explained variance to 58% ($\Delta R^2 = .11$, $F(11, 233) = 29.54$, $p < .001$). Mathematics self-efficacy emerged as significant predictor ($\beta = .34$, $p < .001$), while teaching self-efficacy showed smaller non-significant effects when mathematics self-efficacy was controlled ($\beta = .09$, $p = .18$), likely due to high intercorrelation between self-efficacy types. Notably, including self-efficacy reduced intrinsic motivation's coefficient from .31 to .18 (still significant, $p = .01$) and rendered identified regulation non-significant ($\beta = .09$, $p = .21$), suggesting partial mediation. Amotivation's coefficient also decreased from -.21 to -.11 ($p = .08$), becoming marginally significant. These changes indicate that self-efficacy partially explains motivation's effects on achievement—motivation influences achievement both directly and indirectly through enhanced self-efficacy beliefs.

Formal mediation analysis using bootstrapping procedures confirmed self-efficacy's mediating role in the relationship between intrinsic motivation and academic achievement. The indirect effect of intrinsic motivation on GPA through mathematics self-efficacy proved significant (indirect effect = .18, 95% CI [.12, .25]), accounting for approximately 33% of the total effect. This partial mediation indicates that intrinsic motivation enhances achievement partly by building students' confidence in their mathematical capabilities, which then drives higher performance through increased effort, persistence, and effective learning strategies. However, intrinsic motivation retained significant direct effects (direct effect = .36, 95% CI [.24, .48]), suggesting additional mechanisms beyond self-efficacy through which intrinsic motivation supports achievement—potentially including deeper cognitive processing, greater engagement, or enhanced metacognitive regulation.

The mediating pathways differed somewhat for other motivation types. For identified regulation, mediation analysis revealed that self-efficacy fully mediated the relationship with achievement (indirect effect = .14, 95% CI [.08, .21]; direct effect = .07, 95% CI [-.05, .19]), suggesting identified regulation's achievement benefits operate primarily through confidence development rather than direct motivational effects. Conversely, amotivation's negative relationship with achievement showed only partial mediation through self-efficacy (indirect effect = -.15, 95% CI [-.23, -.09]; direct effect = -.17, 95% CI [-.28, -.07]), indicating that amotivation undermines achievement both by eroding confidence and through other pathways such as reduced effort, avoidance behaviors, or poor self-regulation. These nuanced mediation patterns highlight that different motivation types relate to achievement through somewhat distinct psychological mechanisms, with important implications for intervention design.

Motivational Profiles and Achievement Patterns Across Student Subgroups

Cluster analysis identified three distinct motivational profiles among mathematics education students, characterized by different patterns of intrinsic motivation, extrinsic motivation regulation types, amotivation, and self-efficacy. The largest group (n = 132, 54%) displayed an "Autonomous High Achievers" profile featuring high intrinsic motivation (M = 6.12), high identified regulation (M = 6.24), low controlled extrinsic motivation (M = 3.21 for external regulation), minimal amotivation (M = 1.58), and strong self-efficacy (M = 8.34). This group achieved highest academic outcomes with mean GPA of 3.71 and mathematics course average of 84.2%. A second "Moderately Motivated" group (n = 85, 35%) showed moderate levels across all motivation types (intrinsic M = 4.68, identified regulation M = 5.21, external regulation M = 4.15, amotivation M = 2.38) with moderate self-efficacy (M = 6.84), achieving intermediate outcomes (GPA M = 3.28, mathematics average 76.1%).

The smallest but most concerning cluster, "Struggling and Amotivated" students (n = 28, 11%), exhibited low intrinsic motivation (M = 3.21), moderate to high controlled extrinsic motivation (external regulation M = 5.12), elevated amotivation (M = 4.26), and weak self-efficacy (M = 5.12). This group demonstrated

significantly lower achievement (GPA M = 2.84, mathematics average 68.3%) and reported higher anxiety, lower program satisfaction, and greater consideration of leaving mathematics education. Figure 1 presents the distinctive motivational profiles across these three clusters, illustrating qualitative differences beyond simple high-medium-low distinctions. The profiles reveal that high achievement associates not merely with high motivation generally but specifically with autonomous motivation combined with low amotivation and strong self-efficacy – a constellation suggesting integrated, self-determined engagement rather than pressured, externally controlled striving.

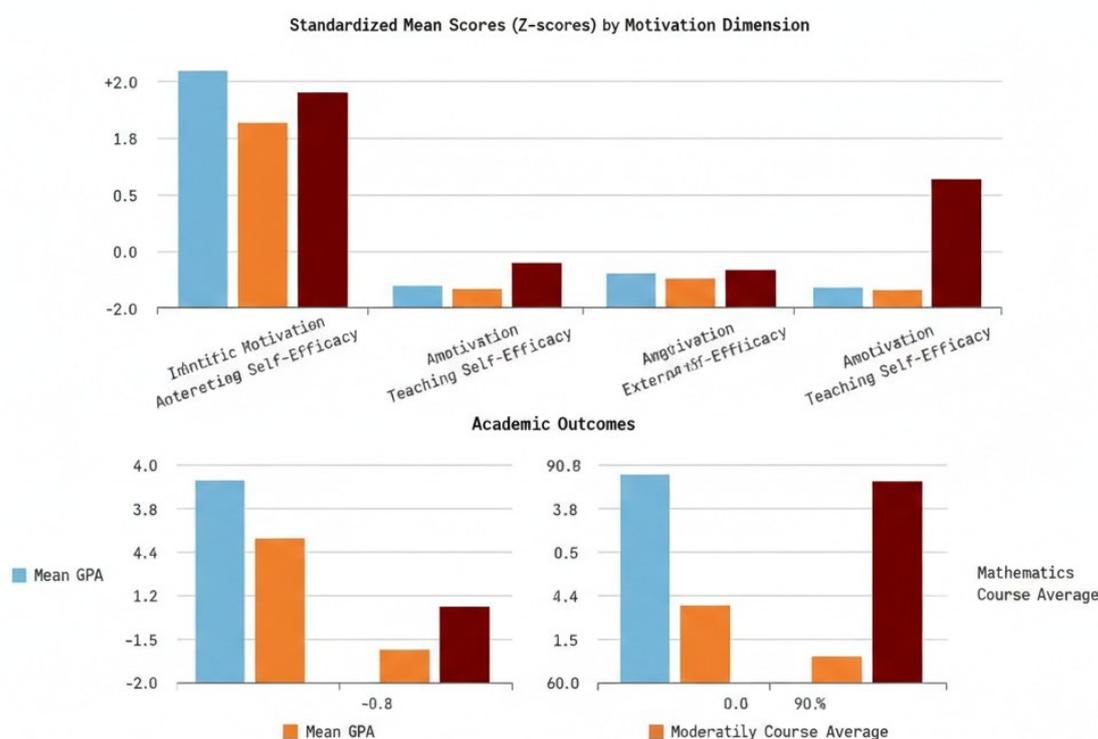


Figure 1. Motivational Profiles of Mathematics Education Student Clusters

Note. Profiles derived from K-means cluster analysis with standardized variables.

All between-cluster differences significant at $p < .001$ (MANOVA)

Examination of demographic and background variables across clusters revealed important patterns. The Autonomous High Achievers cluster contained higher proportions of students reporting positive mathematics learning experiences in secondary school, mathematics-oriented extracurricular activities (math competitions, tutoring), and family encouragement for mathematics pursuits. These students more frequently described mathematics teachers who fostered autonomy, provided conceptual explanations, and created supportive learning environments – suggesting that prior educational experiences shape motivational orientations students bring to university. Conversely, the Struggling and Amotivated cluster

disproportionately included students who reported negative secondary mathematics experiences, characterized mathematics as difficult and anxiety-provoking, and expressed doubts about their mathematical capabilities despite meeting program admission requirements.

Gender analysis revealed nuanced patterns, with female students somewhat overrepresented in the Moderately Motivated cluster and underrepresented in the Autonomous High Achievers cluster despite comparable prior achievement and admission credentials. Further investigation indicated that female students reported significantly lower mathematics self-efficacy than male peers ($M = 6.98$ vs. 7.82 , $t(243) = 4.12$, $p < .001$) despite achieving equivalent grades, reflecting persistent gendered beliefs about mathematical ability documented extensively in literature (Wigfield & Cambria, 2010). This self-efficacy gap partially explained gender differences in intrinsic motivation and achievement, suggesting that addressing female students' confidence in mathematics education programs could enhance both motivation and outcomes. International students showed slight overrepresentation in the Struggling cluster, with qualitative survey responses indicating language barriers in mathematics courses, cultural adjustment stress, and limited peer support networks as contributing factors.

Year of study influenced motivational profiles, with interesting developmental patterns emerging. First-year students distributed relatively evenly across clusters, but progression patterns differed markedly – students beginning in the Autonomous profile typically maintained it throughout their programs, while those initially Moderately Motivated either progressed toward Autonomous patterns (43%) or declined toward Struggling patterns (28%) by fourth year. This divergence suggests that early university experiences prove critical for either consolidating positive motivation or initiating negative spirals where initial struggles undermine confidence and motivation, leading to further difficulties. Students persisting in the Struggling and Amotivated profile beyond first year showed highest attrition rates, with 46% either leaving mathematics education for other majors or departing university entirely – representing significant loss of potential teachers and personal disappointment (Muhsyanur and Mustapha, 2023).

CONCLUSION

This study demonstrates robust positive relationships between autonomous learning motivation, self-efficacy, and academic achievement among Ontario mathematics education students, while revealing concerning patterns wherein struggling students experience compounding motivational and achievement difficulties. Findings emphasize that fostering intrinsic motivation and mathematics self-efficacy should constitute central priorities in mathematics teacher education, achieved through autonomy-supportive instructional practices that provide meaningful choices, emphasize conceptual understanding over procedural performance, connect mathematics to authentic teaching contexts, and create psychologically safe learning environments where struggle is normalized as

productive rather than indicating inadequacy. Programs should implement early identification systems detecting students with struggling motivational profiles, providing targeted interventions including academic counseling, peer mentoring, study skills development, and mathematics anxiety reduction programs before negative patterns become entrenched. Particular attention should address gender-based self-efficacy gaps through explicit discussion of stereotypes, highlighting successful female mathematician role models, and creating supportive peer communities. Faculty professional development should emphasize motivation theory and autonomy-supportive teaching practices given instructors' critical influence on student motivation. Assessment practices should balance accountability with learning support, minimizing controlling pressures while providing informative feedback fostering competence development. Future research should employ longitudinal designs tracking motivational development and achievement trajectories, examine specific instructional practices fostering autonomous motivation, investigate intersections of motivation with mathematics anxiety and identity development, and explore motivation's relationships with teaching practice quality during field placements and early career teaching.

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