The Influence of Academic Resilience and Academic Self-Efficacy Upon Academic Achievement in Medical Laboratory Science Education

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ABSTRACT

As medical laboratory science (MLS) programs continue to expand online course offerings, it is necessary to monitor whether online MLS education prepares students as well as traditional methods. High academic achievement is associated with high academic resilience and self-efficacy scores, particularly in the online environment, yet the moderating effects of these in MLS students were previously unknown. The purpose of this study was to examine whether differences exist between academic achievement in online and campus MLS students and to determine the extent age, gender, grade point average (GPA), and academic resilience and self-efficacy scores can predict the learning environment.

Survey respondents ($n = 173$) were enrolled in nationally accredited online and campus MLS programs. While campus students demonstrated a slightly higher mean GPA in the Mann–Whitney U test ($P < .05$), this difference was not confirmed by logistic regression analysis, in which age and gender were the only significant predictors of learning environment. High academic resilience and academic self-efficacy scores were significantly ($P < .05$) associated with higher GPA in a correlation analysis. Because no significant differences were observed in academic achievement between groups, the results of this study indicate the online and traditional environments may be equally effective in MLS education.

ABBREVIATIONS: ARS-30 - Academic Resilience Scale, BOC - Board of Certification, F2F - face-to-face, GASE - General Academic Self-Efficacy Scale, GPA - grade point average, M - mean, MLS - medical laboratory science, MSLQ - Motivated Strategies for Learning Questionnaire, NAACLS - National Accrediting Agency for Clinical Laboratory Sciences, SD - standard deviation, SPSS - Statistical Package for the Social Sciences.

INDEX TERMS: medical laboratory science, academic performance, distance education, resilience, self-efficacy.

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INTRODUCTION

Traditional face-to-face (F2F) medical laboratory science (MLS) programs have been expanding online course delivery options while historically demonstrating comparable academic outcomes.[1,2] While high academic resilience and self-efficacy are associated with high academic achievement in university students across majors and disciplines, the moderating effects of these in MLS students were previously unknown.[3-5] Further, online and F2F students face different challenges unique to their learning environment with academic self-efficacy and academic resilience reported as important for success in the online environment.[6,7] It is expected that the development of resilience and self-efficacy skills in MLS students will assist them as they navigate challenges inherent in both the academic and professional settings.

The MLS profession is currently experiencing numerous challenges, including unprecedented labor shortages, high employee turnover, closure of training programs, fewer student applicants, low professional visibility, and increased vacancy rates.[8-10] In spite of robust projected job growth for medical laboratory professionals, the MLS profession continues to struggle to recruit due to many factors, including a lack of knowledge of the profession, and workforce vacancies are currently exceeding the number of MLS program graduates.[1,11,12]

MLS programs exist in a variety of structures, including online, F2F, and hybrid formats. The challenges faced by online and F2F MLS students may vary, depending upon their unique situations including demanding workloads, academic responsibilities, extracurricular activities, and employment and family obligations. These commitments can create stress and affect students' physical and mental wellbeing.[8]

Differences in gender within the MLS profession are pronounced with 82.7% of respondents of a recent MLS wage survey reporting female and 17.0% reporting male.[12] An additional difference between online and F2F MLS students is the average age of the student. For example, the mean (M) age of online students is 32 years, and according to the National Student Clearinghouse Research Center, a 3% increase in online bachelor's degree program

enrollment was recently observed in students aged 30 years and older.[13,14]

Academic resilience plays a crucial role in the success of online students, and academic self-efficacy has been identified as one of the important factors influencing academic performance.[15,16] Self-efficacy can be described as one's belief in being able to overcome obstacles and accomplish goals.[17] A systematic review of studies about the relationship of academic self-efficacy and academic achievement found a positive relationship between academic self-efficacy and academic performance in higher education.[5] Students with higher academic self-efficacy are more likely to set challenging goals, persist in accomplishing academic tasks, and achieve at a higher academic level.[5] In contrast, students with lower academic self-efficacy may lack motivation and struggle with academic tasks.[18] Further, students with low self-efficacy are more likely to fear completing tasks and may avoid, postpone, or abandon them.[18,19]

Because the role of academic resilience and academic self-efficacy has not been previously studied in MLS students, the purpose of this study was to examine the moderating effects of academic resilience and academic self-efficacy on the relationship between self-reported grade point average (GPA) and learning environment of bachelor's degree–level MLS students learning in F2F and online formats. The research questions of this study are: (1) Are self-reported GPA of MLS students enrolled in online and F2F programs different? and (2) Do academic self-efficacy, academic resilience, self-reported GPA, gender, and age predict the type of learning environments in MLS students?

MATERIALS AND METHODS

The sampling frame included bachelor's-level students enrolled in U.S. MLS programs accredited by the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS). G*Power was used to calculate the target sample sizes for statistical analysis using an alpha level of .05 and statistical power at 80%.[20] An additional 20% was calculated and added to each to counter the anticipated effects of incomplete survey responses and possible participant attrition. For the Mann–Whitney *U* test, a medium effect size of 0.5 was estimated using Cohen's *d* from a similar study of academic resilience on the choice of pharmacy schools.[21] For the binomial regression analysis, a meta-analysis of the effect of academic resilience in pharmacy school students was used to estimate the effect size ($\eta^2 = 0.01$), which was translated into an appropriate odds ratio of 0.55.[21,22] Using this odds ratio, the H_1 probability was determined to be .31 and the H_0 probability to be .45. A total target sample size of 154 was calculated as needed to maintain statistical power.

After receiving Institutional Review Board approval, program directors of NAACLS-accredited MLS programs were contacted via email with a link to the survey administered through REDCap, a secure web application for building and managing online surveys and databases, which was open for 5 weeks. Participants agreeing to the informed consent criteria were allowed to respond to the survey items.

All variables in the proposed study were measured through a composite survey consisting of 2 valid and reliable questionnaires, the Academic Resilience Scale (ARS-30) and the expectancy component of the Motivated Strategies for Learning Questionnaire (MSLQ), and demographic items created by the researcher.[23,24]

Academic resilience was measured using the ARS-30 questionnaire containing 30 items specifically designed to measure participants' responses to a hypothetical case representing academic adversity.[23] The ARS-30 measured the study participants' cognitive, affective, and behavioral responses to the adverse event, and the score was used to quantify the participants' capacity to return to normal behavior after experiencing academic adversity.[23] Responses to the 30 items in the questionnaire were arranged on a Likert scale from 1–5: *likely* (1), and *unlikely* (5), with higher scores indicating greater agreement with the item, greater adaptability, and increased academic resilience.[23]

The ARS-30 was validated using the General Academic Self-Efficacy Scale (GASE) along with the ARS-30, and a positive correlation between the ARS-30 scores and the GASE scores ($r = .49$) demonstrated concurrent validity of the scale.[23] Internal reliability and construct validity of the ARS-30 instrument were then established. A Cronbach's alpha of .90 demonstrated high internal consistency reliability.[23]

The 6 motivational scales included in the MSLQ developed by Pintrich et al include measures of intrinsic and extrinsic goal orientation and task value (value components), measures of control beliefs and self-efficacy for learning and performance (expectancy components), and test anxiety (affective components).[24] The Self-Efficacy for Learning and Performance subscale of the MLSQ instrument was selected for this study and contained 8 items in the specific context of academic self-efficacy.[24] The Cronbach's alpha score for the subset of 8 questions was .93, indicating high internal consistency reliability.[24]

In the demographic section, participants were asked to self-report their GPA, age, gender, ethnicity, educational setting (online or F2F), student status (full-time or part-time), and employment status (full-time, part-time, or unemployed), and indicate if they were employed in a clinical/medical laboratory or related field, or a nonclinical/medical laboratory field. The demographic variables were created based on best practices using consistent and inclusive language and were placed at the end of the survey.[25,26] The commonly used demographic variables age and gender have demonstrated validity by the classical test theory.[27]

Before performing the data analysis procedures using the Statistical Package for the Social Sciences (SPSS)

software, the data were cleaned, and assumption testing was performed. The Mann–Whitney *U* test was determined to be the most appropriate test for the data because multiple normal distribution assumption tests for the independent samples *t*-test failed. Univariate analyses were conducted to produce descriptive statistics for all variables. The mean and standard deviation (SD) of the participants' ages were used to characterize the sample populations. Because the ARS-30 questionnaire contains both positively and negatively phrased items, the scoring of the positively phrased items was reversed during data cleaning so that a high ARS-30 score indicated greater academic resilience; therefore, reverse coding was performed using the procedure described by Cassidy.[23]

RESULTS

In total, 184 responses were collected in REDCap, surpassing the calculated target sample size of 154. However, 11 survey attempts were not completed and were deleted from the dataset. Of the ARS-30 and MLSQ subset response items ($n = 6574$), 29 skipped items (0.44% of all possible survey items) were identified in SPSS and were replaced with the median scores of each item. The final sample number analyzed was 173.

The sample primarily identified as female (77.50%) and as White or European American (68.21%) with a mean age of 29.73 (SD = 8.90) and a mean GPA of 3.55 (SD = 0.35). The mean age of online students (M = 34.14, SD = 8.95) was somewhat higher than that for F2F students (M = 24.83, SD = 5.75). The majority of MLS students reported working in a medical laboratory or related field (91.72%). Most F2F students were employed part time (78.93%), while most online students were employed full time (82.29%). A much higher percentage of online participants (95.60%) reported being currently employed in a medical laboratory or related field compared to F2F participants (46.34%). The sample characteristics of the study participants enrolled in F2F and online MLS programs are displayed in Table 1.

The ARS-30 scores and MLSQ subscale scores were calculated, and the means and SDs of F2F and online students are displayed in Table 2, along with the means and SDs of GPA. The ARS-30 and MLSQ subscale scores were nearly identical in both groups, although the mean GPA was slightly higher for F2F students (M = 3.62, SD = 0.29) compared to online students ($M = 3.49$; SD = 0.39). The GPA range of the F2F students was 2.8–4.0, and the range for online students was 2.0–4.0.

The difference between the self-reported GPA of F2F and online students was determined to be moderately but significantly higher in F2F students than in online students, $U = 2987.50$, $z = -2.275$, $P = .02$, $r = .17$. The small effect size (.17) of the Mann–Whitney *U* test was calculated using the following formula:

Table 1. Sample characteristics of medical laboratory students in F2F and online educational settings

Variable	F2F *n* (%)	Online *n* (%)
Gender		
Female	53 (64.63)	81 (89.01)
Male	27 (32.92)	10 (10.99)
Nonbinary/other	2 (2.43)	0 (0)
Ethnicity		
Arabic or Middle Eastern	1 (1.22)	3 (3.30)
Asian or Asian American	20 (24.39)	8 (8.79)
Black or African American	2 (2.43)	4 (4.40)
Hispanic or Latino	6 (7.32)	2 (2.20)
Native American or Alaska Native	1 (1.22)	4 (4.40)
Native Hawaiian or Other Pacific Islander	0 (0)	1 (1.10)
White or European American	51 (62.96)	67 (73.63)
Some other race, ethnicity, or origin	1 (1.22)	2 (2.20)
Employment		
Not employed	25 (30.49)	0 (0)
Employed part time	45 (54.88)	12 (13.19)
Employed full time	12 (14.63)	79 (86.81)
Employed in a medical laboratory or related field	38 (46.34)	87 (95.60)
Employed in another field	19 (23.17)	4 (4.40)

Table 2. Means and SDs of ARS-30 scores, MLSQ subscale scores, and GPA for F2F and online MLS students

Variable	F2F ($n = 82$)	Online ($n = 91$)
ARS-30 score	118.68 (15.60)	119.75 (20.39)
MLSQ subscale score	47.20 (7.71)	46.88 (7.33)
GPA	3.62 (0.29)	3.49 (0.38)

Note: Standard deviations (SDs) in parentheses.

$$r = \frac{|z|}{\sqrt{n}}$$

The binomial regression analysis procedure was performed to ascertain the predictive effects of ARS-30 scores, MLSQ subscale scores, GPA, age, and gender on learning environment (Table 3). The logistic regression model was statistically significant, $\chi^2(4) = 71.89$, $P < .001$. The model explained 45.8% (Nagelkerke R^2) of the variance in learning environment and correctly classified 82.5% of cases. Sensitivity was 83.8%, specificity was 81.3%, positive predictive value was 85.1% and negative predictive value was 79.8%.

Table 3. Binomial logistic regression predicting likelihood of educational setting based on academic resilience, academic self-efficacy, GPA, age, and gender

							95% CI for Exp(*B*)	
Model	***B***	***SE***	**Wald**	***df***	***p***	**Exp(*B*)**	**Lower**	**Upper**
Academic resilience	0.003	0.01	.05	1	.82	1.00	0.98	1.03
Academic self-efficacy	−0.005	0.03	.023	1	.88	0.10	0.94	1.06
GPA	−1.21	0.63	3.66	1	.06	0.30	0.09	1.03
Age	0.184*	0.03	30.99	1	< .01	1.20	1.13	1.28
Gender	−1.52*	0.51	8.92	1	< .01	0.22	0.08	0.59

*Note: CI, confidence interval; *B*, unstandardized regression weight; SE, standard error of the coefficient; *df*, degrees of freedom; Exp(*B*), odds ratio.

Of the 4 predictor variables, age and gender were significant. Increasing age was associated with a 1.2-higher odds of being in an online environment. The odds of being enrolled in an online course increased by 4.6 if the person was female.

DISCUSSION

The gender and ethnicity demographics of the study's sample are consistent with the demographic findings reported in the most recent MLS wage survey performed by Garcia et al, with the exception that male students enrolled in MLS programs were 10% higher than those currently employed in the MLS field.[12] The similar demographics between this study and the wage survey illustrate a fairly consistent representation in participant sampling in this study. The mean age of online students in this study was similar to national survey data.[13,14]

A recently published working paper by Altindag et al examined the effect of instruction modality on learning outcomes and demonstrated that students with greater exposure to F2F courses achieved a higher graduation GPA.[28] In this study, self-reported GPA was found to be slightly higher in F2F students than in online students, as tested by the Mann–Whitney *U* test. However, a significant effect of self-reported GPA was not confirmed by the logistic regression analysis. This is consistent with the findings of a meta-analytic review of the effectiveness of online versus F2F educational formats that reported no significant academic achievement differences between F2F and online education.[29,30]

In this study, ARS-30 and MLSQ subset scores demonstrated small to moderate but significant correlations with self-reported GPA in MLS students, similar to the positive correlation of academic resilience and academic self-efficacy with academic performance found in other studies.[3,5,7,17,31] This suggests the development of academic resilience and academic self-efficacy skills in MLS students could help improve academic performance in MLS programs.

The second research question to determine the predictive ability of academic self-efficacy, academic resilience, gender, self-reported GPA, and age to identify MLS student learning environment demonstrated that this model correctly classified the learning environment in 82.5% of the cases. Further, only age and gender were found to be significant predictors of learning environment.

The findings that age and gender are significant predictors of educational environment in this study are consistent with the literature.[13,32] The lower sensitivity of this model indicates there may be more reliable predictor variables, such as technical efficacy and consistency of interest, to predict educational format than those included in this study.[33,34] Another possible explanation of the results could be that the effects of age and gender could be suppressing the effects of academic resilience, academic self-efficacy, and GPA in this model.[35] However, even with the reanalysis of the regression with the age and gender variables removed from the model, academic resilience, academic self-efficacy, and GPA were not significant.

Several limitations are present in this study. First, in this study academic performance was only measured through self-reported GPA. Although self-reported GPA is frequently used in research out of convenience, Kuncel et al advise that self-reported GPA data should be used with caution due to under- and overreporting of actual GPA data.[36] Second, additional objective measures of academic performance, including external board of certification (BOC) exam score results, were not included in this study due to the anonymity of the study participants and impossibility of MLS program directors to release individual student BOC exam scores and actual GPA data.

Although the number of study participants exceeded the minimum number estimated by power calculations, and purposive sampling of MLS program locations was employed, another limitation of the study is that the participants were enrolled in a relatively small number of MLS programs. Although these programs represent diverse geographic locations in the United States, collecting data from more MLS programs would produce a more representative sample with increased generalizability to the MLS student population. Further, due to the inability to control the individual environments in which the online surveys were completed, location bias was present.[37]

It is expected that, as in other disciplines, online education in MLS will continue to expand and be a popular option for MLS students. For MLS educators and preceptors, understanding the factors that may influence the MLS student's choice of learning environment and examining the challenges inherent in online and F2F learning environments can guide the development of interventions and support systems to enhance their education regardless of the learning environment students choose. The construct of resilience in healthcare education and practice has recently emerged as an area of research interest.[31] Educating future healthcare workers about the importance of resilience and self-efficacy and employing interventions that cultivate these attributes in students may equip them with skills to help them succeed in the workplace.

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