frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 09 November 2023
DOI 10.3389/feduc.2023.1279746

OPEN ACCESS

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RECEIVED 18 August 2023
ACCEPTED 24 October 2023
PUBLISHED 09 November 2023

CITATION
Edwards NT, Khalil M, Goodwin RL and Nathaniel T (2023) Improving strategic learning and self-regulation skills among underrepresented minority students in a summer research education training program. *Front. Educ.* 8:1279746. doi: 10.3389/feduc.2023.1279746

Improving strategic learning and self-regulation skills among underrepresented minority students in a summer research education training program

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Introduction: This study examines the effect of educational interventions on strategic learning and self-regulation variables of underrepresented minority students (URMs) who participated in the NIH R25 Research education program.

Methods: The LASSI instrument was administered to 21 URMs who participated in the intervention over 2 years. We collected pre- and post-intervention data before and after the educational intervention.

Results: There was a significant improvement ($p < 0.001$) in all strategic learning and self-regulation parameters including attitude, concentration, information processing, motivation, selecting main ideas, self-testing, test strategies, and time management for the pre and post-assessments.

Conclusion: The results of this study indicate that self-regulated learning strategies in research education programs are important to help URM's chances of advancing along scientific and educational pathways.

KEYWORDS

NIH R25, LASSI, strategic learning, self-regulation, study strategies

1. Introduction

Increasing the representation of racial and ethnic minorities in the biomedical workforce is one of the top priorities for the National Institutes of Health (NIH). For example, the National Institute of Aging (NIA) is leading efforts aimed at increasing the number of underrepresented minority students (URMs) in the area of biomedical research. In line with the NIA's efforts and based on a systems analysis approach, the Research Education Program (REP) of the NIH R25 program was implemented in 2022 to provide opportunities for URMs among universities in South Carolina. The REP program was established to address the lack of well-trained minority Biomedical scientists in South Carolina and has been continuously funded by the NIH and NIA. The framework of the program is summarized in Figure 1. The program's implementation in 2022 expanded the program by initiating a partnership program between the University of South Carolina School of Medicine Greenville and seven other Universities in South Carolina. In addition, the program was expanded to include all the non-historically and historically black colleges and universities (HBCUs) in South Carolina, Anderson University, Benedict College, Claflin University, Clemson University, University of South Carolina Upstate, and North Greenville University. A significant component of the program is the provision of educational intervention activities, including learning strategies such as selecting main ideas, focusing or

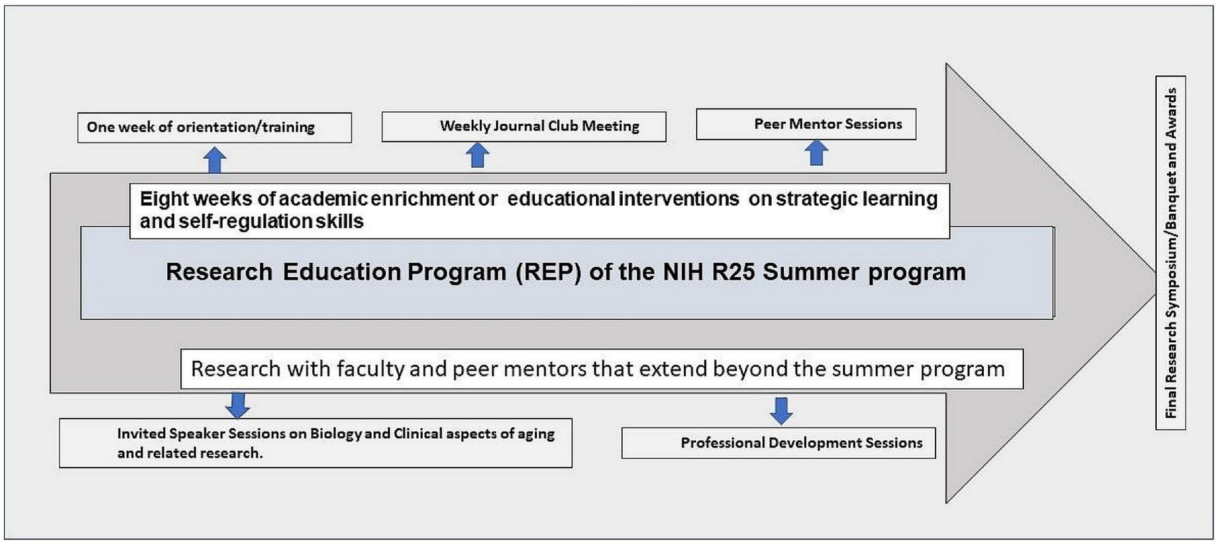

FIGURE 1
The framework of the research education program (REP) of the NIH R25 Summer program NIH R25 program is to increase post-baccalaureate opportunities in biomedical sciences. The goal is to encourage individuals from diverse backgrounds, including those from groups underrepresented in the biomedical and behavioral sciences, to pursue further studies or careers in research and foster a better understanding of biomedical, behavioral, and clinical research and its implications.

concentrating, time management skills, test-taking techniques, availability of resources, and thought processes related to identifying, acquiring, and constructing meaning for important new information. The lack of these self-regulated learning(SRL) strategies has been reported to contribute to the poor representation of URMs in STEM programs (Lukes et al., 2020). A key element of strategic learning is the will, skill, and self-regulatory ability of the individual URMs to explore different learning strategies including cognitive and behavioral strategies. According to Zimmerman (2008), SRL learning strategies are the actions and processes used to acquire information or skills that involve purpose including the instrumentality perceptions of learners. While all learners use regulatory processes to some degree, SRL learners are aware of the strategic relations between regulatory processes and they use these strategies to achieve their academic goals (Brenner, 2022). The systematic use of metacognitions, and motivational and behavioral strategies are the key features of SRLs (Ha et al., 2023). Because SRL includes the cognitive, metacognitive, behavioral, motivational, and emotional/affective aspects of learning (Panadero, 2017), it represents the strategy that allows a considerable number of variables such as self-efficacy and cognitive strategies that influence learning to be studied in a holistic approach. Therefore, providing education interventions that enhance strategic learning skills such as attitude, and motivational levels of the students, and self-regulation skills such as concentration, time management, self-testing, and using academic resources can help remove barriers and lift URM's interests, commitment, and ability to persist in STEM fields.

1.1. Learning and study strategies

Previous studies have documented the use of Learning and Study Strategies (LASS) in different learning contexts to achieve the intended learning outcomes in different study programs such as medical education (Khalil et al., 2018; Nabizadeh et al., 2019), effective learning strategies (Geller et al., 2018), and predictors of undergraduates' emotional engagement (Abulela et al., 2023). A popularly used model of LASS was proposed and revised by Weinstein and Palmer (1987). Based on the revised model, LASS is described as the behaviors and beliefs employed by students during learning and studying (Abulela et al., 2023). This model includes 10 strategies or sub-scales: information processing, selecting main ideas, test strategies, anxiety, attitude, motivation, concentration, self-testing, study aids, and time management (Abulela and Davenport, 2020). Therefore, LASS is a tool that can be used to collect noncognitive information to inform appropriate interventions evaluate learning strategies interventions, and predict students' success (Sisa et al., 2023). The LASS 10-scale items or strategies include three major components of strategic learning: skill, will, and self-regulation (Prevatt et al., 2006). While information processing, selecting main ideas, and test strategies are within the skill component of strategic learning, the will component of strategic learning includes attitude, motivation, and anxiety (Prevatt et al., 2006). The self-regulation component is concentration, time management, self-testing, and study aids (Weinstein and Palmer, 1987; Khalil et al., 2017). The LASS sub-scales associated with the skill variable of strategic learning include information processing, selecting main ideas, and test strategies (Khalil et al., 2017). In the current study, these scales assess URMs' learning strategies, skills, and thought processes associated with identification, acquiring, and constructing meaning for important new information, ideas, and procedures, and how they prepare for and demonstrate their new knowledge on tests or other evaluative procedures. The LASS sub-scales associated with the will variable of strategic learning include attitude, motivation, and anxiety. These scales examine URMs' receptivity to learning new information, their attitudes and interest in STEM programs in graduate school, their self-discipline, and their willingness to apply the effort necessary to complete academic requirements. The LASS

sub-scales related to the self-regulation component of strategic learning include concentration; time management; self-testing and study aids. These sub-scales examine how students manage, or self-regulate and control, their learning process by using their time effectively, focusing their attention and maintaining their concentration over time, and using study supports such as review sessions, tutors, or available resources. Evaluating the different LASS sub-scales provides an appraisal of how receptive the URMs are to learning new information and an understanding of the importance of their college experience (Plener et al., 2017; Isik et al., 2018). It also indicates self-discipline, the desire to put extra effort into meeting their academic goals, and the degree to which they are concerned about their academic self-efficacy (Wilson et al., 2015). In addition, measuring self-regulation by focusing on concentration, time management, and self-testing provides insight into URM's level of self-control, how well they manage their time, their ability to stay focused, and how well they can successfully meet their academic learning demands (Abulela and Davenport, 2020). Therefore, all strategic learning and self-regulation components interact to create effective and efficient learning.

One of the key promises of the NIH R25 is to encourage URMs in STEM to pursue different careers in STEM research, which requires self-awareness of how they learn and study. Strategic learners have the skill, will, and self-regulation needed to be effective and efficient learners in varied educational environments. While various definitions have been used to describe self-regulated and strategic learning, we focus on the degree to which students are metacognitively, motivationally, and behaviorally active participants in their learning process (Zimmerman, 2001). This approach allows us to implement academic intervention activities that will enable URMs to take a proactive role in monitoring their learning, maintaining motivation, and engaging in behaviors that lead to success in their research, poster developments, poster presentations, conferences, and manuscript development and submission during the summer program.

1.2. Study rationale

One widely implemented approach to increase URMs' interest in STEM programs is providing a comprehensive summer bridge experience. Such programs aim to help students transition from college to graduate programs with an interest in the STEM fields. In addition, the program offers supplementary instruction for key introductory courses, financial aid, early involvement in undergraduate research, peer and faculty mentoring, and social activities. Although these systemic programs have recorded significant improvements (Beasley and Fischer, 2012; Richter et al., 2016; Kricorian et al., 2020), most did not include education intervention to provide strategic learning and self-regulated skills, including the right attitude, managing examination-related anxiety, motivation, concentration, information processing, test and studying strategies and using academic resources skills. Moreover, the body of research on URMs' poor representation in STEM programs also benefits from a broader investigation of how education interventions on strategic learning and self-regulation can be implemented to enhance engagement and higher academic skills among URMs in STEM programs (Allen et al., 2015). Therefore, it is important to provide academic skills to lift URM's interests, commitment, and ability to persist in STEM fields (Estrada et al., 2016). Given the lack of education interventions on strategic learning and self-regulation in many funded URMs summer programs (Estrada et al., 2016), the overall research goal of this study is to identify the academic support needs of URMs in a summer research education program for the planning and implementation of learner-specific interventions to improve their academic skills. Specifically, the study examines the differences in the 10 LASS subscale scores for the pre assessments of URMs in a summer research education program to identify gaps in learning and study strategy skills that require intervention to address areas that need improvement. The study was guided by a research question.

Are there statistically significant differences in the 10 LASS subscale scores between the pre- and post-assessment after the intervention?

> *Hypothesis*: There are statistically significant differences in the 10 LASS subscale scores between the pre- and post-assessment which indicates the effect of the intervention in improving the 10 LASS subscale scores.

In this study, we focused on implementing education interventions to improve strategic learning to guide URMs to an awareness of their strengths and areas of improvement in how they learn and study what they have learned. To examine the effect of educational interventions on strategic learning and self-regulation variables, we collected pre- and post-intervention data using the LASS before and after the educational intervention. Using LASS allows us to determine areas of improvement while simultaneously implementing educational interventions specific to those needs. Since URM's academic experiences affect their chances of advancing along STEM career pathways (Estrada et al., 2016; Murphrey et al., 2022), it is important to provide necessary academic skills and use educational resources to aid in developing effective learning and studying strategies. When URMs can access resources essential to their success, they will be able to employ them with limited interferences to increase their participation rate in STEM programs.

2. Methods

2.1. Participants

During the 2-year implementation of the LASS Learning and Study Strategies, there was a total of 26 students who took the LASS pre-assessment. Of the 26, only 21 of the students completed the post-assessment. Therefore, only the data of the 21 students who completed both assessments are included in the results. Four students completed the pre- and post-assessment during the summer of 2021, and the remaining 17 URMs completed the evaluations during the summer of 2022. The demographics of the 21 URMs are presented in Table 1. The table presents information on race, gender, class classification, and location of Universities for the recruitment of students. The age range was 18–24 years. For the recruitment process, applicants were required to have a grade point average of 3.0 or higher. In addition to personal identification information, the application requests a personal statement on career goals, interest(s) in STEM, and reasons for participating in the program. Applicants were also asked to provide

TABLE 1 Demographics of URMs (n = 21) that completed the LASSI assessment as a part of the NIH R25.

Parameters	Characteristics	Frequency	Percentage
Race			
	African American	16	76.19%
	Asian	1	4.76%
	Socioeconomically Disadvantaged	3	14.29%
	Hispanic	1	4.76%
Gender			
	Male	2	9.52%
	Female	19	90.48%
Classification			
Parameters	Sophomore	8	38.1%
	Junior	7	33.3%
	Senior	6	28.57%
Location of University			
	Clemson	3	14.29%
	Columbia	5	23.815%
	Greenville	5	23.815%
	Charleston	2	9.52%
	Greenwood	1	4.76%
	Orangeburg	2	9.52%
	Anderson	2	9.52%
	Spartanburg	1	4.76%

Information on race/ethnicity, gender, class classification, and universities that URMs were recruited for the program. The age range was between 18 and 24 years.

TABLE 2 The description of the LASS 10-subscale instrument used in this study for the three major components of strategic learning including skill, will, and self-regulation.

LASS sub-scale	Descriptions
Anxiety (ANX)	The extent in which worry is placed on school and academic performance.
Attitude (ATT)	Attitudes and interests in regard to doing well academically.
Concentration (CON)	The ability to direct and maintain attention on academic tasks.
Information Processing (INP)	The extent in which imagery, verbal explanation, organization skills, and reasoning skills are used to learn.
Motivation (MOT)	Diligence combined with self-discipline and the willingness to put effort in completing academic requirements.
Self-Testing (SFT)	The extent in which review and comprehension strategies are used to gain understanding.
Selecting Main Ideas (SMI)	The ability to distinguish between important information and less important or supporting details.
Time Management (TMT)	The extent in which time management principles are used in academic situations.
Test Strategies (TST)	The extent in which test preparation and test taking strategies are implemented.
Using Academic Resources (UAR)	The extent in which support and resources are used to learn and retain information.

Information processing, selecting main ideas, and test strategies are variables in the skill component of strategic learning. The will variable of strategic learning includes attitude, motivation, and anxiety, while the self-regulation variables are concentration, time management, self-testing, and academic resource use.

their GPA, college transcript, and two letters of recommendation. Applications were reviewed, selected candidates were interviewed, and finalists were determined and accepted to the program.

2.2. Instrument

The LASS, 3rd Edition (Weinstein et al., 2016), was used for the assessment in this study. LASS comprises 60 items that are depicted using a 10-scale system of evaluation used for the pre and post-assessment. In response to greater emphasis on student-initiated help-seeking, a new scale was created. The Using Academic Resources (UAR) Scale was created to replace the Study Aids Scale, and this fits with our current research in self-regulated learning and student learning assistance. Table 2 presents the LASS 10-subscales descriptions for the assessment of URMs' awareness and implementation of learning and study strategies. In addition, the table describes how LASS was used to collect noncognitive information to identify the characteristics of URMs, their support needs, and the planning and implementation of learner-specific interventions for URMs. As shown in Table 2, the LASS scale used in this study consists of items for each of the following subscales: (1) Anxiety, (2) Attitude, (3) Concentration, (4) Information Processing, (5) Motivation, (6) Selecting Main Ideas, (7) Self-Testing, (8) Test Strategies, (9) Time Management, (10) Using Academic Resources (Weinstein and Lane, 2016). Each statement has a response that includes a five-part Likert that consists of (a) Not at all typical of me, (b) not very typical of me, (c) somewhat typical of me, (d) fairly typical of me, very much typical of me (Weinstein and Lane, 2016). In their response, for the pre-and post-assessment, URMs are expected to rank the statements according to how each statement represents how they think, behave, or process information. Through the assessment, an understanding of how the learning and study strategies of an individual relate to their aptitude, determination, and self-regulation that make up strategic learning was determined. Understanding this relationship allowed us to implement educational interventions to change and increase positive knowledge and study strategies. Administration of LASS was implemented during the pre- and post-assessment of the inventory, which measures initial and final thoughts, behaviors, attitudes, beliefs, and growth over time. Scores for each subscale are produced automatically. All scores are computed and made available immediately once the assessment has been submitted online.

2.3. Procedure for the implementation of the intervention

An orientation to the importance of learning and study strategies was facilitated at the beginning of the NIH R25 summer programs. The conclusion of the orientation included online instructions on

how to assess the inventory. URMs who participated in the NIH R25 program were required to take the LASSI pre-assessment within a week of the orientation during both years. LASS was administered online, including instructions to the students on accessing the assessment, the student's unique key to take in the evaluation, and a LASSI profile report once the review has been completed. The student profile provides a rationale for how to interpret their LASS scores for each subscale. Within a week after the administration of the LASS, a 30-min meeting was scheduled with all students. The meeting provided the opportunity to address the 10-LASS scores that are less than 50%. The one-on-one session was scheduled to discuss the results, followed by intervention to address areas that need improvement. The intervention focuses on how to plan and implement specific measures to improve learning and study strategy skills. Therefore, the education intervention's core was focused on identifying the weaknesses of each URM and then developing strategies unique to each URM's needs. For example, we focused on examination-taking strategies that can help prevent mistakes in reading and understanding examination questions, time management such as blocking distractions, creating a daily planner, organizing, prioritizing, and coordinating tasks. In addition, we provided strategies to improve concentration, focus on the classroom and manage examination-related anxiety or nervousness before taking the examination. We provided different studying strategies to prevent the memorization of concepts for better information processing. The education intervention also included identifying various school resources, including the library, counseling, and other resources to help the URMs, and using a variety of student-active teaching activities to increase motivation. These education interventions were tailored to each student's needs. An expert in academic enrichment and education intervention led the activities.

The URMs combined the knowledge and learned information from the orientation, assessment, and intervention with their weekly reflections and mentoring to implement a plan for remediation and improvement in areas of weaknesses following the intervention. Students had the opportunity to implement some of the improvements in the different activities of the program, including organizing, prioritizing, and coordinating tasks during their research activities. They also worked on identifying resources, creating a daily planner, reading and processing materials during journal club, and developing interactive activities during their research, poster development, poster presentations, conferences, and manuscript development. They also had the opportunity to use their Individual Development Plans (IDP) to identify educational activities that will allow them to improve further and practice their desired learning and study strategies. A LASS post-assessment was conducted during the last week of the summer program during both years. The post-assessment was also completed online.

2.4. Data analysis

Data from the LASS pre- and post-assessment was analyzed using Statistical Package for Social Sciences v 26.0 for Windows (SPSS, Chicago, IL). All data were tested for normality using the Shapiro–Wilk test to assess the data for homogeneity. The Shapiro–Wilk statistic associated with the data was $W = 0.890$, indicating that no significant deviations from normality were detected ($p = 0.74$) in our data which allows the use of parametric tests in our analysis. Descriptive statistics were calculated for each assessment. The results were presented as all variables' mean and standard error. Student's *t*-test paired sample analysis was used to compare differences in anxiety, attitude, concentration, information processing, motivation, selecting main ideas, self-testing, test strategies, and time management between pre and post-test following the intervention. This allows us to compare all the parameters for strategic learning and self-regulation before and after the intervention for each URM. Statistical significance was established at $p < 0.05$. In our power analysis, we used a single-group design to test whether the mean (μ) is different from 0 (H0: $\mu = 0$ versus H1: $\mu \neq 0$). The comparison was made using a two-sided, one-sample *Z*-test, with a Type I error rate (α) of 0.05. To detect a mean of $\mu 1 = 1$ (or $\delta 1 = \mu 1 - \mu 0 = 1$), with a current sample size of 21, and with a current *Z*-test statistic of 0, the conditional power was 0.99313. The predictive power of our sample size of 21 was 0.7612, and the futility index was 0.00687. The power was computed using PASS 2023, version 23.0.2. The effect size was calculated for all statistically significant values using Cohen's d value to quantify the effect of size between pre and post intervention. In interpreting the effect size, we used the commonly used interpretation in referring to effect sizes as small ($d = 0.2$), medium ($d = 0.5$), and large ($d = 0.8$) based on benchmarks suggested by Cohen (2013). Since each variable in the pre and post intervention has a different standard deviation, we also computed the glass's delta values.

3. Results

Table 3 presents the results for the 10 parameters for strategic learning and self-regulation, including, attitude, concentration, anxiety, information processing, motivation, selecting main ideas, self-testing, test strategies, and time management. There was a significant difference ($p < 0.001$) in all strategic learning and self-regulation parameters categories for the pre and post-assessments. As shown in the table, all parameters including, attitude, concentration, information processing, motivation, self-testing, selecting main ideas, anxiety, time management, test strategies, and using academic resources, significantly improved after the intervention. Moreover, URMs' performance following the intervention was above 50th percentile in all the 10 sub-scale scores, indicating that our intervention improves all the 10 sub-scale scores of LASS including reducing anxiety. Self-testing is a key component of an individual's ability to self-regulate, and showed the largest increase from the preassessment to the post-assessment, followed by using academic resources, information processing, anxiety, concentration, test strategies, selecting main ideas, motivation, and time management, while attitude recorded the lowest increase. The result indicates that using LASS and educational interventions helps to improve anxiety, attitude, concentration, information processing, self-testing, test strategies, and use of academic resources skills of URMs. The effect size reflect a large size ($d > 0.8$), for all LASS sub-class and was larger than Cohen's *d* value for large size effect ($d = 0.8$), revealing the stronger relationship between our pre and post assessments, indicating the practical significance of our results.

TABLE 3 The result for the parameters for strategic learning and self-regulation.

Variables	LASSI Pre-assessment Mean + SD ($N = 21$)	LASSI Post-assessment Mean + SD ($N = 21$)	T-Stat	*P*-value	Cohen's *D* values	Glass's delta values
ANX	41.43 ± 6.12	61.43 ± 5.30	4.91	<0.001**	3.494	3.267
ATT	62.57 ± 5.22	71.81 ± 4.55	4.74	<0.001**	1.887	1.770
CON	53.38 ± 5.45	73.38 ± 4.68	4.58	<0.001**	3.937	3.670
INP	53.58 ± 6.36	73.76 ± 4.58	4.63	<0.001**	3.641	3.173
MOT	62.86 ± 4.94	76.71 ± 3.88	3.21	<0.001**	3.118	2.804
SFT	45.71 ± 5.87	73.81 ± 5.92	3.15	<0.001**	4.767	4.787
SMI	47.62 ± 6.13	61.57 ± 6.13	3.31	<0.001**	2.276	2.275
TMT	58.1 ± 6.07	71.9 ± 4.59	3.35	<0.001**	2.565	2.734
TST	55.29 ± 6.67	71.67 ± 3.09	3.03	<0.001**	3.151	2.456
UAR	44.38 ± 7.35	64.57 ± 5.35	3.13	<0.001**	3.141	2.747

Mean ± SD, *p*-values were determined using a Student's *t*-test, and the effect size was calculated for all statistically significant values using Cohen's *d* value to quantify the effect of size between pre- and post-intervention test. Since each of the variables in the pre and post intervention has a different standard deviation, we also computed the glass's delta values using only the standard deviation of the pre-intervention variables. ANX, anxiety; ATT, attitude; CON, concentration; INP, information processing; MOT, motivation; SFT, self-testing; SMI, selecting main ideas; TMT, time management; TST, test strategies; UAR, using academic resources, *$p < 0.05$; **$p < 0.01$ (two-tailed); SD, deviation.

4. Discussion

For over a decade, the self-regulated and strategic learning framework has been used to examine study activities and academic success across various levels of education (Hayat et al., 2020; Xu et al., 2022a,b, 2023). Educational interventions have been reported to have a significant positive relationship between strategic learning, self-regulated strategies, student understanding, retention, and attitudes toward STEM programs (Sandi-Urena et al., 2011; Biwer et al., 2022; Edwards et al., 2023). However, few investigations have focused on these strategies among URMs and academic success in STEM programs. We focused on this critical line of inquiry by investigating the effect of an educational intervention to promote strategic learning and self-regulation skills among URMs in an NIH R25 summer program. We analyzed pre and post-intervention data for URMs, including anxiety, attitude, concentration, information processing, motivation, selecting main ideas, self-testing, test strategies, and time management. In our results, we observed a significant improvement in all strategic learning and self-regulation parameters in the post-assessment following the intervention. Our results indicate the importance of providing academic intervention to promote strategic learning, including the right attitude, motivation, and reduced anxiety to improve URM's development of effective learning and studying strategies. The goal of the education intervention component of the summer NIH R25 program was to improve academic skills by providing tools to guide URMs to an awareness of their strengths and areas of improvement in how they learn and study what they have learned. The intervention focused on the students' covert and overt thoughts, behaviors, attitudes, motivations, and beliefs to identify strategies to help them thrive in undergraduate and graduate environments and STEM programs. This allowed us to provide more effective learning and studying strategies using appropriate interventions that motivate and encourage URMs.

The improvement in strategic education and self-regulation parameters in the post-assessment following the intervention indicated that URMs benefited from the interventions administered to improve areas of weakness in their academic skills. After the intervention, we observed that attitude, concentration, information processing, self-testing, test strategies, and use of educational resources significantly improved. Strategic learning is grounded in the student's attitude, and motivational levels, and our interventions positively impact these skills among URMs (Hattie and Donoghue, 2016; Riestra et al., 2019; Hsu and Goldsmith, 2021). Self-regulation is identifiable in concentration, time management, self-testing, and using academic resources subscales (Jouhari et al., 2016; Evans, 2021). These parameters significantly increased after our education intervention. This result indicates that the intervention successfully helped URMs increase their self-control, manage their time, stay focused, and successfully meet their academic learning demands during their research, poster development, poster presentations, conferences, and manuscript development.

An essential component of our education intervention program is providing URMs the opportunity to monitor their learning, maintain motivation, reduce anxiety and engage in behaviors that lead to success in their research, poster developments, poster presentations, conferences, and manuscript development and publication. Therefore, our education intervention activities allowed URMs to take responsibility for their learning by participating in various self-regulated learning strategies, such as reviewing their learning strategies and peer knowledge to develop their metacognitive plan to solve problems in their research and other educational activities during the summer program.

Our intervention provides different learning strategies to prevent memorization of concepts for better processing of information during preparation for journal presentations. URMs interacted among themselves socially and during research using a variety of student-active learning activities to increase motivation. Our URMs identify different resources to implement their research by collecting, analyzing, and submitting scientific data to high-profile journals. Most of the submitted articles have been accepted

and published. Our result indicates the importance of implementing a self-regulated learning framework to enhance academic success among ethnically diverse students and academic success in science.

4.1. Limitations

Despite the significance of our study, this study's result must be interpreted considering a few limitations. Twenty-one URMs participated in the program. The small sample size may affect the generalization of our findings. Due to the challenges of recruiting male URMs to the summer program, male and female participants were not equally represented in the sample collection. The educational intervention activities were implemented only during the summer period. Therefore, we could not follow up to track the long-term effect of our education intervention to promote learning strategies and self-regulation in their different institutions. There is a tendency for bias in the self-reported data from LASS. For future research, an increase in the number of participants per year and a combined analysis of the total number of participants over the five-year course of the NIH R25 program will be evaluated. An emphasis on recruiting more male URMs in the program will be implemented during the recruitment process. In addition, the educational intervention activities will be included within the short-term and long-term goals developed by the URMs so that there will be a more extended implementation and area for growth.

5. Conclusion

URMs are disproportionately represented in the biomedical sciences due to the lack of educational interventions in funded grants to improve their strategic learning and self-regulation skills. The implementation of educational interventions in a summer REP NIH R25 program resulted in a significant improvement in all strategic learning and self-regulation parameters in the post-assessment following the intervention.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

All experimental protocols were approved by the institutional review board of the University of South Carolina for ethics (approval number: Pro00113174). All methods were carried out in accordance with the Declaration of Helsinki for the conduct of scientific research.

Author contributions

NE: Formal analysis, Investigation, Writing – original draft, Writing – review & editing. MK: Formal analysis, Methodology, Writing – review & editing. RG: Conceptualization, Investigation, Writing – review & editing. TN: Conceptualization, Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. An NIH R25 grant funded this study.

Acknowledgments

We thank NIH R25 participants for their support in implementing this program.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Abulela, M. A., and Davenport, E. C. Jr. (2020). Measurement of invariance of the learning and studies strategies inventory (LASSI-II) across gender and discipline in Egyptian college students. *Educ. Sci.* 20, 32–49. doi: 10.12738/jestp.2020.2.003

Abulela, M. A. A., Mrutu, A. P., and Ismail, N. M. (2023). Learning and study strategies as predictors of undergraduates' emotional engagement: a cross-validation approach. *SAGE Open* 13:215824402311558. doi: 10.1177/21582440231155881

Allen, J. M., Muragishi, G. A., Smith, J. L., Thoman, D. B., and Brown, E. R. (2015). To grab and to hold: cultivating communal goals to overcome cultural and structural barriers in first-generation college students' science interest. *Transl. Issues Psychol. Sci.* 1, 331–341. doi: 10.1037/tps0000046

Beasley, M. A., and Fischer, M. J. (2012). Why they leave: the impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Soc. Psychol. Educ.* 15, 427–448. doi: 10.1007/s11218-012-9185-3

Biwer, F., de Bruin, A., and Persky, A. (2022). Study smart – impact of a learning strategy training on students' study behavior and academic performance. *Adv. Health Sci. Educ.* 28, 147–167. doi: 10.1007/s10459-022-10149-z

Brenner, C. A. (2022). Self-regulated learning, self-determination theory and teacher candidates' development of competency-based teaching practices. *Smart Learning Environments.* 9:3. doi: 10.1186/s40561-021-00184-5

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Academic Press.

Edwards, N., Nathaniel, T., Goodwin, R., Khalil, M., McPhail, B., Fowler, L., et al. (2023). Research education program for underrepresented minority students: students' perception of academic enrichment and research activities. *Int. J. Aging Hum. Dev.* 96, 63–75. doi: 10.1177/00914150221106652

Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., et al. (2016). Improving underrepresented minority student persistence in STEM. CBE life. *Sci. Educ.* 15, 1–15. doi: 10.1187/cbe.16-01-0038

Evans, C. (2021). *A self-regulatory approach to assessment in higher education*.

Geller, J., Toftness, A. R., Armstrong, P. I., Carpenter, S. K., Manz, C. L., Coffman, C. R., et al. (2018). Study strategies and beliefs about learning as a function of academic achievement and achievement goals. *Memory* 26, 683–690. doi: 10.1080/09658211.2017.1397175

Ha, C., Roehrig, A. D., and Zhang, Q. (2023). Self-regulated learning strategies and academic achievement in south Korean 6th-graders: a two-level hierarchical linear modeling analysis. *PLoS One* 18:e0284385. doi: 10.1371/journal.pone.0284385

Hattie, J. A. C., and Donoghue, G. M. (2016). Learning strategies: a synthesis and conceptual model. *NPJ Sci. Learn.* 1, 1–13. doi: 10.1038/npjscilearn.2016.13

Hayat, A. A., Shateri, K., Amini, M., and Shokrpour, N. (2020). Relationships between academic self-efficacy, learning-related emotions, and metacognitive learning strategies with academic performance in medical students: a structural equation model. *BMC Med. Educ.* 20:76. doi: 10.1186/s12909-020-01995-9

Hsu, J., and Goldsmith, G. (2021). Instructor strategies to alleviate stress and anxiety among college and university stem students. *CBE Life Sci. Educ.* 20:es1. doi: 10.1187/cbe.20-08-0189

Isik, U., Tahir, O. E., Meeter, M., Heymans, M. W., Jansma, E. P., Croiset, G., et al. (2018). Factors influencing academic motivation of ethnic minority students: a review. *SAGE Open* 8:215824401878541. doi: 10.1177/2158244018785412

Jouhari, Z., Haghani, F., and Changiz, T. (2016). Assessment of medical students' learning and study strategies in self-regulated learning. *J. Adv. Med. Educ. Prof.* 4, 72–79.

Khalil, M. K., Hawkins, H. G., Crespo, L. M., and Buggy, J. (2017). The relationship between learning and study strategies inventory (LASSI) and academic performance in medical schools. *Med. Sci. Educ.* 27, 315–320. doi: 10.1007/s40670-017-0400-x

Khalil, M. K., Williams, S. E., and Gregory, H. H. (2018). Learning and study strategies correlate with medical students' performance in anatomical sciences. *Anat. Sci. Educ.* 11, 236–242. doi: 10.1002/ase.1742

Kricorian, K., Seu, M., Lopez, D., Ureta, E., and Equils, O. (2020). Factors influencing participation of underrepresented students in STEM fields: matched mentors and mindsets. *Int. J. STEM Educ.* 7:16. doi: 10.1186/s40594-020-00219-2

Lukes, L. A., Jones, J. P., and McConnell, D. A. (2020). Self-regulated learning: overview and potential future directions in geoscience. *J. Geosci. Educ.* 69, 14–26. doi: 10.1080/10899995.2020.1820828

Murphrey, T. P., Carter, C. R., Regisford, E. G. C., Carson, L. E., Butler-Purry, K., Carter-Sowell, A. R., et al. (2022). An examination of the paths of successful diverse stem faculty: insight for programming. *Frontiers in Education* 7:7. doi: 10.3389/feduc.2022.767476

Nabizadeh, S., Hajian, S., Sheikhan, Z., and Rafiei, F. (2019). Prediction of academic achievement based on learning strategies and outcome expectations among medical students. *BMC Med. Educ.* 19:99. doi: 10.1186/s12909-019-1527-9

Panadero, E. (2017). A review of self-regulated learning: six models and four directions for research. *Front. Psychol.* 8:422. doi: 10.3389/fpsyg.2017.00422

Plener, P. L., Groschwitz, R. C., Brähler, E., Sukale, T., and Fegert, J. M. (2017). Unaccompanied refugee minors in Germany: attitudes of the general population towards a vulnerable group. *Eur. Child Adolesc. Psychiatry* 26, 733–742. doi: 10.1007/s00787-017-0943-9

Prevatt, F., Petscher, Y., Proctor, B. E., Hurst, A., and Adams, K. (2006). The revised learning and study strategies inventory: an evaluation of competing models. *Educ. Psychol. Meas.* 66, 448–458. doi: 10.1177/0013164405282454

Richter, K., Acker, J., Adam, S., and Niklewski, G. (2016). Prevention of fatigue and insomnia in shift workers—a review of non-pharmacological measures. *EPMA J.* 7, 1–11. doi: 10.1186/s13167-016-0064-4

Riestra, A. M., Morales, A. J., and Mercer, F. (2019). Targeting the achievement gap: strategies toward removing inequities in undergraduate immunology education. *Front. Immunol.* 10:10. doi: 10.3389/fimmu.2019.02906

Sandi-Urena, S., Cooper, M. M., and Stevens, R. H. (2011). Enhancement of metacognition use and awareness by means of a collaborative intervention. *Int. J. Sci. Educ.* 33, 323–340. doi: 10.1080/09500690903452922

Sisa, I., Garcés, M. S., Crespo-Andrade, C., and Tobar, C. (2023). Improving learning and study strategies in undergraduate medical students: a pre-post study. *Healthcare (Basel).* 11, 1–13. doi: 10.3390/healthcare11030375

Weinstein, M. J. M., and Lane, M. A. (2016). Sociality, hierarchy, health: comparative biodemography: a collection of papers. *Evol. Med. Public Health* 2016, 67–68. doi: 10.1093/emph/eow004

Weinstein, C. E., and Palmer, D. R. (1987). *LASSI user's manual*. H&H publishing.

Weinstein, C. E., Palmer, D. R., and Acee, T. W. (2016). *LASSI user's manual: for those administering the learning and study strategies inventory*. *3rd* Edn. San Diego, CA: H & H Pub.

Wilson, D., Bates, R., Scott, E., Painter, S., and Shaffer, J. (2015). Differences in self-efficacy among women and minorities in stem. *J. Women Minorities Sci. Eng.* 21, 27–45. doi: 10.1615/JWomenMinorScienEng.2014005111

Xu, L., Duan, P., Padua, S. A., and Li, C. (2022a). The impact of self-regulated learning strategies on academic performance for online learning during COVID-19. *Front. Psychol.* 13:1047680. doi: 10.3389/fpsyg.2022.1047680

Xu, Z., Zhao, Y., Liew, J., Zhou, X., and Kogut, A. (2023). Synthesizing research evidence on self-regulated learning and academic achievement in online and blended learning environments: a scoping review. *Educ. Res. Rev.* 39:100510. doi: 10.1016/j.edurev.2023.100510

Xu, Z., Zhao, Y., Zhang, B., Liew, J., and Kogut, A. (2022b). A meta-analysis of the efficacy of self-regulated learning interventions on academic achievement in online and blended environments in K-12 and higher education. *Behav. Inform. Technol.* 39, 1–21. doi: 10.1080/0144929X.2022.2151935

Zimmerman, B. J. (2001) *Theories of self-regulated learning and academic achievement: an overview and analysis. Self-regulated learning and academic achievement: theoretical perspectives*, *2nd* Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers, 1–37

Zimmerman, B. J. (2008). Investigating self-regulation and motivation: historical background, methodological developments, and future prospects. *Am. Educ. Res. J.* 45, 166–183. doi: 10.3102/0002831207312909