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Customized student inventory for the smooth transition of low achievers to advanced learners

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ABSTRACT

Introduction: Each undergraduate medical student embarks upon a unique learning journey. A few students achieve their targets smoothly but some land in the group labeled low achievers. We aimed to identify the low achievers, determine their problems, identify their learning preferences and then address these using appropriate remedial measures, thus creating a customized student inventory.

Methods: Low achievers were categorized into study and control groups. The study group students' learning problems were categorized into cognitive, affective, interpersonal and structural domains based on their responses to a questionnaire and were allotted to a faculty in-charge, who identified their learning preferences based on the VARK questionnaire. Customized remedial measures were administered to the study group. Academic performances of both study group and control group students were compared.

Results: The majority of students of the study group had affective problems, inability to understand the subject with their method of learning, mismanagement of time, problems in interacting with students and teachers. The study group preferred a multimodal approach to learning. Following the implementation of the inventory among study group students, there was a significant improvement in their academic performance when compared with their previous examination results. The academic performance significantly improved with a large effect size in study group when compared to the control group.

Conclusion: Understanding the problems of each medical undergraduate low achiever student, applying customized student inventory with targeted remedial measures directed at their learning problems and preferred mode of learning enabled a smooth transition of low achievers to advanced learners.

Introduction

Learning, an essential component of a student's life has many ups and downs in its journey to achieve the desired goal. Each undergraduate medical student embarks on a unique learning journey that varies with the individual student's capacity to understand, comprehend, synthesize and conceptualize the intended learning objectives. A few students achieve their targets smoothly but some walk through the thorns and obstacles, with a struggle that majority of the times may eventually land

them in the group, labeled slow learners, poor performers, or low achievers, though there exist definitive interpretations for these.

Low achievers are students whose academic performance scores are not satisfactory because of various problems such as lack of motivation, physical and emotional needs, personality, cognitive abilities, study strategies, etc (Arulampalam et al., 2007; Austin et al., 2007; Bansal et al., 2006; Dzulkifli and Alias 2012; Hojat et al., 2002; Kilminster et al., 2007; Kusurkar et al., 2013; Rajkamal and Prema, 2018). Slow learners are those who have decreased ability in rate and depth to learning the necessary academic skills when compared with other students of the same age group (Macdonald Cobb 1961). It is imperative to identify whether these students are actually slow learners or if they are low achievers due to varied other problems and difficulties they face. If the low achievement is because of the problems they face then that has to be targeted for not only the student's academic betterment but also for their holistic growth.

Whichever the professional field a student may have selected as his/her career, there is bound to be a percentage of students who may face difficulties/ problems in their academic progress leading them to become low achievers. Vaughn et al. (1998) modified Quirk's definition of a problem learner as 'A learner with an academic performance that is significantly below performance potential because of a specific affective, cognitive, structural, or interpersonal difficulty'. Based on Quirk's and AAMC studies, they have identified four types of problems learners: a) affective class of problem learners are those who are dealing with personal adjustment events, b) cognitive class of problem learners has problems with written and/or oral communication, spatial-perceptual problems, poor fund of knowledge or poor integration of materials, c) structural class of problem learners are learners who are unable to structure their experiences in the environment, d) The interpersonal class of problem learners are learners who have difficulty interacting with others (Quirk, 1994; Tonesk and Buchanan, 1987; Vaughn et al., 1998). Low achievers can have only one or a combination of the above-mentioned problems. With the specific knowledge of the type of problem, the teacher's interaction with the learner becomes easier and targeted measures can be implemented to overcome, and solve their problems.

Every student has a predilection for specific learning techniques which decides their academic progression. VARK, a questionnaire developed at Lincoln University identifies the preferences of students and the particular mode for effective information dispensing for better acquisition of knowledge. It identifies the learner based on the mode preferred for learning as visual, aural, read and write or kinesthetic mode learner or a combination of these called as a multimodal type of learner. Used for undergraduate medical students, especially low achievers; identifying their mode preferred for learning can be a cornerstone for developing learning strategies that are custom made for individual students and can also target their cognitive class problems (Fleming, 1995).

Undergraduate first-year medical students in India, face a daunting uphill task to conceptualize three preclinical subjects, Anatomy, Biochemistry and Physiology, within a limited period of time amidst various challenges they need to overcome such as adjusting to the new atmosphere, different learning environment, lack of experience in handling medical life workload and their own interpersonal issues (Saxena et al., 2014). As a result of these, many of them could land up in the group of low achievers. If not handled in the beginning stage itself by a customized remedial inventory, their ambition of becoming a successful health care professional will be in jeopardy. We, the medical teachers being the facilitators, guides and support providers need to handle these issues effectively in the best interest of the students, society and the nation.

Since there are very few studies on customized student inventory and their effectiveness in low achievers among the Indian undergraduate medical students, we planned this study to identify the low achievers, determine the problems they face, identify their preferred mode of learning and then address these using appropriate remedial measures, thus creating a customized student inventory to facilitate their dream journey of becoming advanced learners. We compared the results of these students with the previous year students who did not undergo any remedial measures.

Material and methods

The present prospective interventional case control study was conducted for a period of four months in the department of Physiology of a private medical college of a Deemed to be University in Mangalore, Karnataka, India. The institute ethics committee approval was ob-

tained before the commencement of the study (Ref no: 2019/101). After obtaining the written informed consent, forty-three first-year MBBS students of 2019 batch (N1, study group) who had scored less than 50 percent scores (low achievers) in their formative assessment were recruited for the study. Written informed consent was obtained from each participant after describing in detail the full procedure and purpose of the study. Before developing the customized student inventory, the needs assessment for the study was carried out based on the feedback given by the alumni and their parents. The results of the study group were compared with the formative assessment scores of fifty-three students of previous year (2018 batch), low achiever students, who formed the control group (N2) of our study.

Steps involved in development and evaluation of customized student inventory for study group

Identification of low achievers of study group

The study group students who had secured less than 50 percent scores in their formative assessment in Physiology were identified as low achievers and included in the study.

Categorization of study group students' problems

The study group students were asked to answer a pre-tested validated structured questionnaire. Questionnaire items were based on Vaughn et al. (1998) identification of problem learners. This questionnaire was constructed taking into consideration the views and inputs from the faculty and student alumni. Cognitive interview, internal consistency with test-retest reliability (Chronbach alpha score), pre-testing and piloting of the questionnaire were undertaken. Feedback and validation for this inventory was obtained with the experts in the field before implementing it. This questionnaire assessed the type of problems the study group students faced while preparing for the formative examinations. The questionnaire was administered using Google forms and their responses were collected on a Likert scale. The problems of low achievers were categorized into cognitive, affective, interpersonal and structural domains based on their responses.

Categorization of the study group students based on the preferred mode of learning

The study group students were then divided into small groups of four students each. Each group was then allot-

ted to one teacher in Physiology (faculty in-charge). The faculty in-charge categorized each student into the type of learner based on the VARK questionnaire which is a simple, freely available online, easy to administer tool that encourages a student to describe their behavior in a manner they can identify with, and accept (The VARK questionnaire, 2021). The aim of administering the VARK questionnaire was to understand the preferred sensory modality (or modalities) of the student for their effective learning. The study group students were then identified as visual, auditory, read and write, or kinesthetic or a combination of these, multimodal learners.

Administering customized remedial measures

To address the cognitive problems of the study group, they were given a few concepts-based questions at the beginning of each week (first day of each week). To help them out further in answering the questions, in addition to their regular study material (text books), reliable and verified (by subject experts) multimedia web links were shared through University's Learning Management System (LMS) portal, YENGAGE based ILIAS platform for visual/auditory type of learners. The kinesthetic learners were involved in preparing concept maps and solving Multiple Choice Questions via E-portal links. All study group students were then directed to submit a written assignment on the 5th day of each week targeting all types especially read and write type of learners.

The affective, interpersonal and structural problems of study group students were individually unearthed by student welfare officer and their respective mentors on regular basis with in-depth discussions and counseling. Appropriate specific measures were then undertaken by welfare officer and their mentors to help the study group students solve/ find a solution to their problems.

Continuous progress monitoring

Each study group student's progression was evaluated by a written assignment which they had to submit by the 5th day of the week. On the 6th day of the week, the faculty in-charge had one-to-one interaction with students and the students were graded. In addition, all their doubts pertaining to the topics were cleared and the feedback regarding their assignment and progress were informed to them at the end of one to one interaction. This was easily implementable and feasible, as the teacher meets the student only once a week for 15min and all other
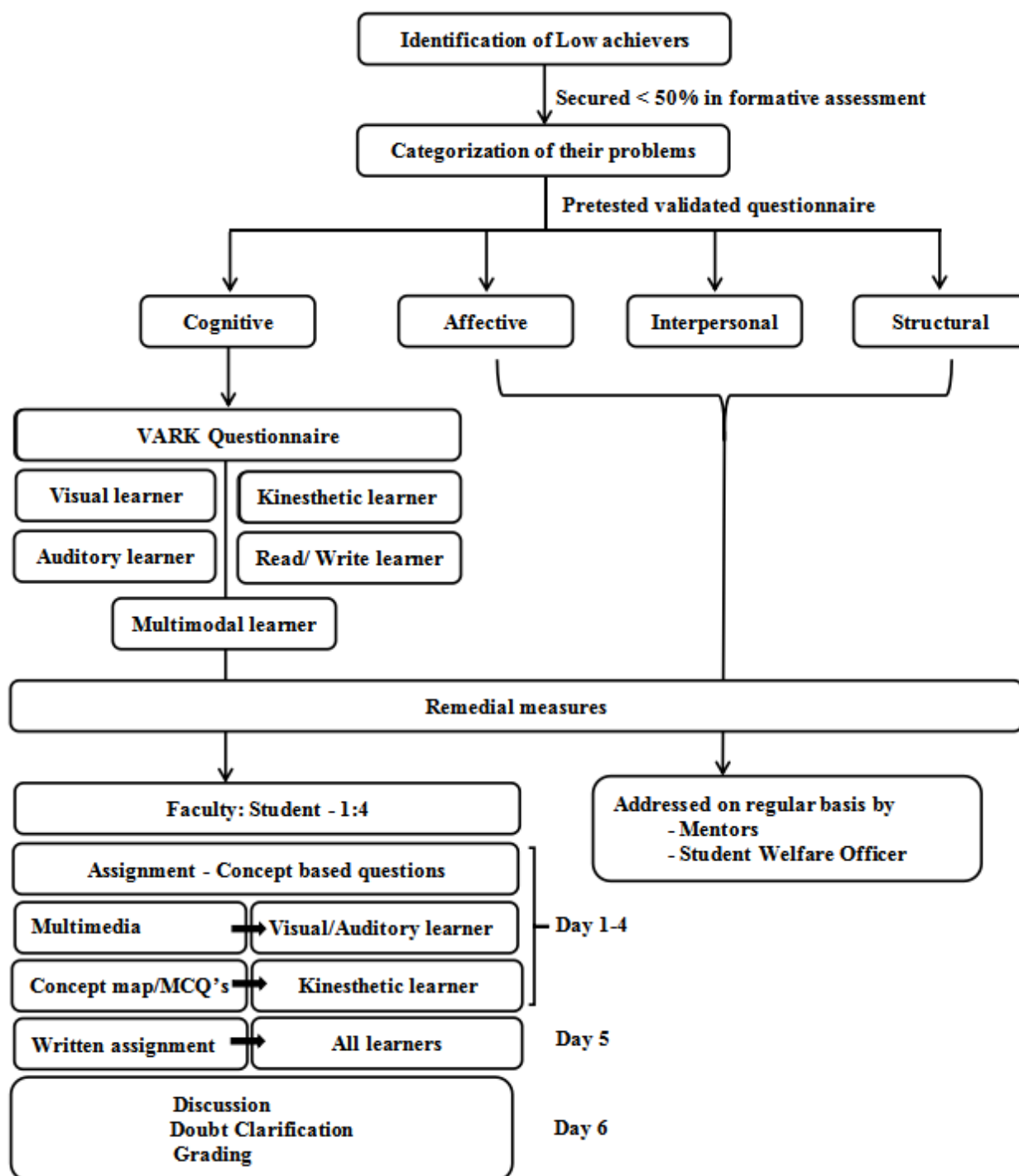
FIGURE 1. Flow chart showing the customised remedial measures given to the study group.

contacts are mainly through the LMS portal.

These customized remedial measures (Figure 1) were done till their next formative assessment. The academic performances of the study group students before and after the intervention were recorded and also compared with that of the control group.

Statistical analysis

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) statistics software (version 25) and Microsoft Excel. The study group students were analyzed for the problems they faced and type of learner they are, and this data is presented as frequencies and percentages. The normally distributed continuous data of academic performance (formative assessment scores) of both the groups have been presented as mean±SD.

TABLE 1: Study group students' responses on their affective problems (N1=43).

Affective problems	Responses				
	Strongly agree (%)	**Agree (%)**	**Neutral (%)**	**Disagree (%)**	**Strongly Disagree (%)**
I feel difficulty in adjusting to this sudden change of environment	7 (15.9)	17 (38.6)	13 (29.5)	5 (11.4)	2 (4.5)
I feel difficulty in managing relationship problems	1 (2.3)	5 (11.4)	13 (29.5)	16 (36.4)	9 (20.5)
I am disturbed due to death/ ill health of a family member	3 (6.8)	3 (6.8)	3 (6.8)	17 (38.6)	18 (40.9)
I am feeling sad due to low scores in the recent examination (Class test, Internal examination)	13 (29.5)	21 (47.7)	5 (11.4)	2 (4.5)	3 (6.8)
I am developing a fear of future exams due to my poor academic performance	12 (27.3)	16 (36.4)	5 (11.4)	8 (18.2)	3 (6.8)
I feel guilty to be not be able to perform in examinations up to my expectations	13 (29.5)	22 (50.0)	7 (15.9)	1 (2.3)	1 (2.3)
I think am losing my self confidence	7 (15.9)	15 (34.1)	8 (18.2)	8 (18.2)	6 (13.6)
I feel I won't be able to learn the subject as required	4 (9.1)	19 (43.2)	6 (13.6)	12 (27.3)	3 (6.8)
I feel I lack the required motivation to excel in my studies	6 (13.6)	12 (27.3)	15 (34.1)	9 (20.5)	2 (4.5)

Before and after remedial measures academic performance of the study group students were compared using students paired t-test. The scores were then compared with the control group using unpaired t-test. All tests are two-tailed and *P* value< 0.05 was considered significant.

Results

The affective problems of the study group

The analysis of affective problems of the study group (Table 1) showed that the majority of students had difficulty in adjusting to the new environment. Getting poor scores in the exam has decreased their mood and is creating anxiety towards future exams. The students have begun to develop guilt for failing and feel that they will not be able to learn the subject as required. Even though they are feeling like losing their self-confidence, only a few students feel like they lack motivation.

The cognitive problems of the study group

The assessments of cognitive problems of the study group (Table 2) show that the students feel like they have a deficiency in their reading and writing skills. They are not able to focus when the topics are too vast and feel like they are missing information during studying. They also have difficulty in visualizing concepts

in physiology and integrating them with anatomy and biochemistry. They lack confidence in their speaking abilities and frequently miss out on key words while answering questions.

The structural problems of the study group

The results in Table 3 show that the study group students are not able to manage time in a beneficial way. They spend too much time on non-essential work with inappropriate and overuse of smart phones/laptops and are not able to give sufficient time for regular studies.

The interpersonal problems of the study group

The study group students seem to have no difficulty in interacting with other students but do have problems while interacting with teachers and in conveying their opinions. They do feel that they need help for their overall improvement in establishing good social and interpersonal relationships (Table 4).

VARK analysis of the study group

The questionnaire-based analysis of learning showed that the majority of students (%) prefer learning by aural and kinaesthetic sensory modalities (Figure 2). Analysis of individual students showed that the majority percent-

TABLE 2: Study group students' responses on their cognitive problems (N1=43).

Cognitive problems	Responses				
	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
I feel there is some deficiency in my reading skills	10 (22.7)	20 (45.5)	5 (11.4)	6 (13.6)	3 (6.8)
I feel there is some deficiency in my writing skills	9 (20.5)	19 (43.2)	7 (15.9)	8 (18.2)	1 (2.3)
I feel I am never able to complete given assignments on time	4 (9.1)	9 (20.5)	13 (29.5)	14 (31.8)	4 (9.1)
I am not able to visualize the concepts in physiology	8 (18.2)	15 (34.1)	10 (22.7)	9 (20.5)	2 (4.5)
I am not confident in my speaking abilities	8 (18.2)	19 (43.2)	8 (18.2)	8 (18.2)	1 (2.3)
I feel my English language is poor	3 (6.8)	10 (22.7)	15 (34.1)	12 (27.3)	4 (9.1)
I am not able to integrate physiology with anatomy and biochemistry	7 (15.9)	16 (36.4)	12 (27.3)	7 (15.9)	2 (4.5)
I am not able to answer questions when too many topics are to be studied	14 (31.8)	18 (40.9)	6 (13.6)	5 (11.4)	1 (2.3)
I feel like I am always missing some information while studying	6 (13.6)	27 (61.4)	5 (11.4)	5 (11.4)	1 (2.3)
I feel like I have forgotten the basics what I have studied in my school and college days	5 (11.4)	12 (27.3)	12 (27.3)	13 (29.5)	2 (4.5)
I miss important words while answering questions	5 (11.4)	22 (50.0)	13 (29.5)	3 (6.8)	1 (2.3)

TABLE 3: Study group students' responses on their structural problems (N1=43).

Structural problems	Responses				
	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
I always lag behind in completing my work	8 (18.2)	17 (38.6)	12 (27.3)	7 (15.9)	0 (0)
I am not able to prepare a time table for studying	13 (29.5)	17 (38.6)	11 (25.0)	3 (6.8)	0 (0)
I spend too much time doing non essential work	8 (18.2)	21 (47.7)	10 (22.7)	5 (11.4)	0 (0)
I feel I am not able to do regular studies	9 (20.5)	27 (61.4)	6 (13.6)	2 (4.5)	0 (0)
I feel I am spending more time on mobile phones and laptops for entertainment.	7 (15.9)	13 (29.5)	11 (25.0)	13 (29.5)	0 (0)

age of students were multimodal learners (Figure 3).

Progress monitoring and comparing with control group

Table 5 showed that the average academic scores attained by the study group students in theory examination 8.46 more after remedial measures. There was a 22% increase in their scores and had a large effect size of 1.065. The difference seen was statistically significant ($P<0.0001$). When compared with the control group, there is a significant improvement in marks obtained by the study group post remedial measures ($P=0.001$). The results showed 39.5% of the students of study group have secured more than 50% scores following the remedial measures (Figure 4).

TABLE 4: Study group students' responses on their interpersonal problems (N1=43).

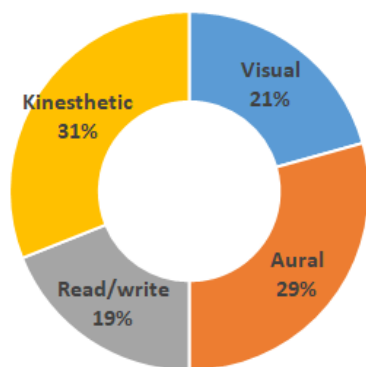| Interpersonal problems	Responses				
	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
I am having difficulty in interacting with other students	0 (0)	6 (13.6)	9 (20.5)	22 (50.0)	7 (15.9)
I am having difficulty in interacting with teachers	5 (11.4)	13 (29.5)	13 (29.5)	10 (22.7)	3 (6.8)
I feel too shy in front of others to convey my opinion	7 (15.9)	16 (36.4)	8 (18.2)	11 (25.0)	2 (4.5)
I feel I am excessively eager to do things	3 (6.8)	3 (6.8)	27 (61.4)	8 (18.2)	3 (6.8)
I feel I can easily make other people do as I please	2 (4.5)	4 (9.1)	24 (54.5)	12 (27.3)	2 (4.5)
I do not like to mix with people of other language/state	0 (0)	1 (2.3)	12 (27.3)	13 (29.5)	18 (40.9)
I need alcohol/medications to control my cravings	0 (0)	0 (0)	2 (4.5)	11 (25.0)	31 (70.5)
I feel I need professional help for my overall improvement	5 (11.4)	18 (40.9)	14 (31.8)	6 (13.6)	1 (2.3)

FIGURE 2. Percentage distribution of the prefered mode of learning of the study group students (N1=43).
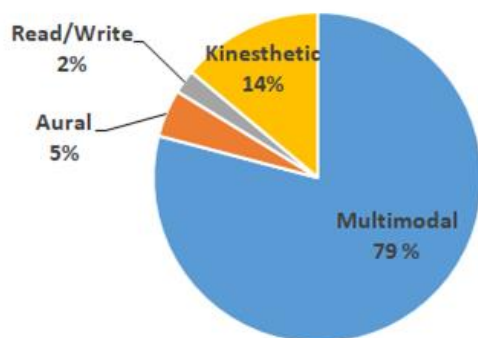

FIGURE 3. Percentage distribution of study group based on the type of learners (N1=43).

TABLE 5: Comparison of the students' academic performance (formative assessment scores).

Academic Progress Monitoring	Before Mean ± SD	After Mean ± SD	Effect Size (Cohen's D)
Theory examination scores of study group (N1=43) (scores out of 100)	38.35±6.89	46.81±8.33*	1.07
Theory examination scores of Control group (N2=53) (scores out of 100)	36.11±7.61	40.58±9.56	0.52
P Value	0.14	0.001*	

P-value by Chi square test, *P <0.05 is significant; Cohens D > 0.8 is large effect.
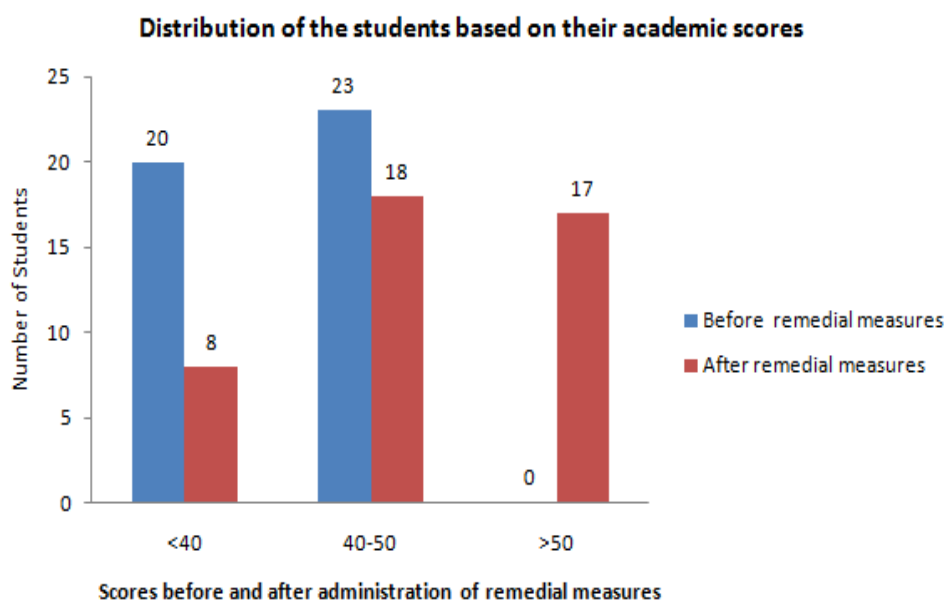

FIGURE 4. Distribution of the study group students based on their academic scores before and after administration of remedial measures (N=43).

Discussion

There is a need to identify the students who need special care (low achievers) to improve their academics with a definitive set of techniques, activities and practices to void off the deficiencies in the remedial process. The present study was conducted to identify the problems faced by first-year undergraduate medical students in their academics and address their concerns by a customized student inventory. The results showed that various factors have contributed to the study group students becoming low achievers, namely affective problems, inability to understand the subject with their method of reading and writing skills, time mismanagement and problems in interacting with students and teachers. On implementation of the inventory among the study group of students, there was a significant improvement in their academic performance when compared with the control group.

Anxiety has a strong association with self-efficacy, self-concept and overall achievement among the students. Once the student's performance deteriorates in an examination, it worsens the anxiety and manifests as poor concentration in studies, difficulty in coping due to pressure, social isolation, decreased cognitive and comprehension skills (Huberty, 2009). We observed that the anxiety of the study group students as a result of decreased academic scores in the examinations created a fear factor among these students further aggravating their ability to concentrate on the subject and improve their score. A similar observation was seen among 254 first and second-year medical students of the University of Medicine and Pharmacy in Romania, where the academic performance decreased inversely with anxiety scores (Zung Self-rating Anxiety score). They stated that academic anxiety increases before the examination sessions (Mihăilescu et al., 2016).

In another study conducted to find out the factors associated with stress, anxiety and coping states of first and second-year medical students during examinations by Balaji et al. revealed significant stress levels in those students who have secured seats in the management quota, living in shared hostel accommodation and from a nuclear family with significantly more anxiety levels before the examination. The students used the coping strategies for improving the academic performance which was statistically significant. This highlights the need for different problem solving coping strategies to be adopted by the students with the help of the teacher to enhance their academic performance (Balaji et al., 2019).

Reading and writing skills are essential components that decide the quality of learning. These are learned over a period of time by a combination of acronyms, concept maps, concentration techniques and note taking strategies with individual variations. Students who lack these skills will have difficulty in their learning process which influences their examination scores. Our study showed that deficiency in the reading and writing skills of students affected their scores in the examination. This is in accordance with the study conducted on 279 students of the medical college at Shiraz University of Medical Sciences where students' self-efficacy and their metacognitive learning strategies with respect to reading and writing had an impact on their learning-related emotions affecting the students' academic performance (Hayat et al., 2020). In a study conducted at Mysore, Karnataka on the first year to final year medical students showed that reading skills and memorizing techniques have a profound influence on academic performance. With appropriate intervention, results improved significantly (Kumar et al., 2016).

A student who has good metacognitive skills will have automatic awareness of his/ her own knowledge and an ability to understand, control and manipulate his/ her own cognitive processes. Statistically, a significant difference was observed in the metacognition scores of first-year medical students at the beginning of the academic year when compared with the final year students which show that students at the end of the academic year exhibit better ability to plan learning strategies, monitor and evaluate their own thoughts which were observed in a study conducted on 159 first-year medical students at the University of Malaya (Hong et al., 2015).

Our study revealed that poor time management resulted in decreased academic performance of students. Academic adaptability in professional education is an important factor that contributes to student success. It is a well-planned process of adjustment to self, studies, stimulating learning environment, motivational factors, good attitudes and time management. If these are not managed effectively, it can result in learning disabilities and academic burnout. Those who adapt well, fare well in their academics. This was observed by Xie et al. involving 1977 Chinese medical students in a cross-sectional study at Harbin Medical University, Qiqihar Medical University, Jiamusi University and Chengdu Medical College. They concluded that academic adaptability had a significant impact on academic burnout, the learning process and academic performance. Those students who could adapt well to these essentials, showed lesser education burnout, active learning and better academic performance (Xie et al., 2019). According to a study conducted at the Department of Medical Education, Dow University of Health Sciences, Karachi involving 652 medical college students, a significant association was observed between time management and academic performance which further supports our results (Sarfaraz et al., 2017).

A good interpersonal relationship with friends, peers and teachers with communication skills to express difficulties and find their solutions has a profound influence on the academic journey of a student. We found that those who could not interact with teachers and peers in solving their doubts or problems, scored badly in their examinations. Quality interactions with friends and mentors had a profound influence on alleviating stress. Socializing and sharing difficulties with friends and teachers is always considered as a motivational factor contrary to being lonely and separated from the group (Jones, 1983).

Our study group students preferred a multimodal approach for learning that includes a combination of visual, aural, read/write and kinesthetic sensory modalities. The majority of the students opted for aural and kinesthetic sensory modalities. The preferential method of learning style decides the inherent capacity of a student's learning process. If the subject or the topic is taught in the student's desired learning method, the student's learning ability increases. In contrast, the study conducted at Kasturba Medical College, Mangalore involving 500 under-

graduate second-year medical students of two consecutive batches who preferred aural (45.5%) and kinesthetic (33.1%) learning styles did not show any correlation on comparing with their academic performances (Urval et al., 2014). This contrast could be because we have specifically studied only the low achievers and their preferred learning modalities and our customized remedial measures were directed at their preferred learning modalities which lead to increased academic performance by them in comparison to our control group.

With the successful implementation of our inventory involving customized remedial measures to address various types of problems in learning which had resulted in poor academic performance in low achievers, we achieved enhanced academic performance among study group students. Chou et al. (2019) prescribed 26 guidelines involving systems-level interventions and recommendations for individual learners, and lists of 'Do's, Don'ts and Don't Knows'. This model explored various causes for students struggle with their academics, addressed contextual issues, resource management, effective feedback culture, aligning assessment methods with desired objectives, support group tutoring to address the common problems faced by the slow learners by early identification, faculty development programs, self-assessment and regular follow up with proactive interventions.

The feasibility of our remedial measures delivery model might have been an issue since it required additional time of contact with the students. But with appropriate resource mobilization strong willingness and dedication of the teachers in the best interest of the students, we could overcome this. We have tried to solve the issue of lack of time with the help of technology, which is easily accessible and inherently attention-grabbing and promises unparalleled educational opportunities to promote student-centered and personalized learning (Haynes and Shelton, 2018). Also, using an electronic portal for communication helps seamless interaction between the teacher, and student at the time of their convenience, thus assisting the teacher to facilitate and monitor the student's learning process.

The customized inventory designed by us only improves students' performance in the theoretical exam and not the practical exam and this forms the limitation of our study. Developing measures targeting both the theoretical and practical exam performance of students

by adding the psychomotor domain to the inventory forms the future scope of our study. Our limited sample size was one of the limitations of the study as our intervention was only targeted at low achievers.

Conclusion

From our study, we concluded that the majority of the study group students who were low achievers experienced difficulty in adjusting to a new environment as the affective problem. Their cognitive problem included a deficiency in reading and writing skills. Structural problems comprised of time mismanagement and interpersonal problem included difficulty in interaction with their teachers. The majority of our study participants were multimodal learners and on application of customized student inventory with targeted remedial measures directed at their learning problems and preferred mode of learning, there was a significant improvement in their academic performance enabling their smooth transition from low achievers to advanced learners.

Acknowledgment

Conflict of interest

The authors declare no conflicts of interest.

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