

## Diagnosongs: a novel approach to fuel active learning and creativity in undergraduate medical education

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### ABSTRACT

The holistic development of the knowledge-seeker has always been the endeavor of most educational institutions. At Melaka Manipal Medical College (Manipal Campus), Manipal, India, the personal and professional development module in the first-year medical curriculum addressed issues such as time and stress management, doctor-patient relationship, communication skills, empathy and team building. The present study was an effort to introduce two more aspects of education, *i.e.*, active learning and creativity into the curriculum. The students in the second semester of their MBBS course were divided into control (n=70) and 7 test groups (n=10 in each). Test groups were allotted a clinical topic based on which they were asked to construct a case scenario according to a template consisting of case title, case history, clinical signs and symptoms, laboratory investigations and treatment. After 'Turnitin' analysis to check for plagiarism, the case scenarios were vetted by a clinician based on predetermined indicators. The case scenarios were then converted into 'Diagnosongs' by students (songs which would describe a clinical case based on which a diagnosis can be made). Students used power point slides and Adobe Flash to synchronize the presentation of the 'Diagnosongs' to an audience consisting of their classmates in the test groups and faculty. Each student in the audience was asked to give the diagnosis for the cases, and a week later answer an MCQ test based on the content of the case scenarios. Student and faculty feedback on the multiple benefits of this novel student-centered creative activity were collected on a 5-point Likert scale and have been discussed.

#### Keywords:

*Diagnosongs, case scenarios, creative thinking, active learning, collaborative learning, student-centered*

### INTRODUCTION

Education helps develop the human mind to realize its potential. Hence it is imperative that education always focuses on the holistic development of the knowledge-seeker. The modalities used in such an endeavor need to be fine-tuned based on the societal needs and the expectations from the profession in question (Shankar and Piryani, 2009; Densen P, 2011) In this regard, the Melaka Manipal Medical College (MMMC), Manipal, India, had taken a few steps to integrate core curriculum delivery with personal and professional development module (PPD module). This module helps build professionalism

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(Komattil R 2016), by addressing issues such as time and stress management, doctor-patient relationship, communication, empathy and team building, to name a few.

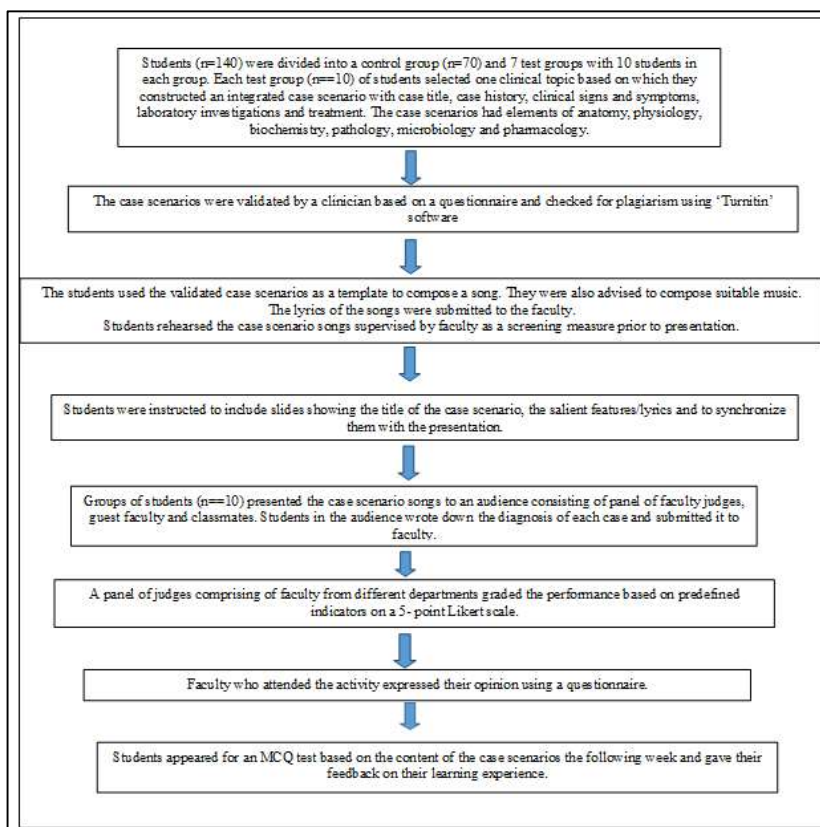
Active learning is a corner stone of all successful educational programmes (Berkhout et al., 2018) and at MMMC, this was represented by self-directed learning (SDL) (Cho et al., 2017), problem-based learning (PBL) (Roche et al., 2016), case-based learning (CBL) (Roche *et al.*, 2018; Roche *et al.*, 2019) and practical sessions. The PBL and CBL serve as a means of integrating the pre-clinical (anatomy, physiology and biochemistry) subjects of the first year with para-clinical subjects (pathology, pharmacology and microbiology) of the second year, to make learning relevant in the clinical context. While case-based activities are recognized as tried and tested tools for student-centered delivery of education, the triggers designed for these activities have always been formulated by experts in the field, keeping in mind the curricular needs and the context of the programme (McLean, 2016). However, based on previous successful experiments with students designing triggers for case-based learning, the present study with triggers designed by students was envisaged, with the twin goals of fusing active learning and creativity. It was thought that such an activity would address an aspect of education which was not dealt with within the PPD module and would basically encourage students to think beyond the established facets of medical education.

## OBJECTIVES

- To promote independent (non-teacher-directed) knowledge gathering beyond the curriculum of the first year, using standard textbooks of medicine and digital media
- To enhance active learning, integration and retention of knowledge
- To stimulate creative thinking by constructing case scenario songs to be assessed by experts, thus promoting a musical approach to learning

## METHODS

The study design (**Figure 1**) was submitted to the Institutional Research Committee (IRC) with all the relevant details. Appropriate questionnaires were prepared, and approval was obtained from the IRC. Voluntary consent was obtained from students after briefing them regarding the structure and contents of the study.



**Figure 1:** Flowchart representing the study design.

Students of MBBS in the first year of their course (n=140), were divided into one control group (n=70), 7 test groups consisting of 10 students each, based on their order in the attendance register, so as to have an equitable distribution, devoid of any bias. The control group did not take part in the activity but answered an MCQ test based on the content related to the 'Diagnosongs', a week following the activity. A list of 7 clinically relevant topics, which were familiar to the students from previous classes was compiled. Each group of students was assigned one of these topics by picking lots and asked to design a case scenario based on it. They were instructed to work under the leadership of the team leader, chosen for the purpose, by the respective team. The teams were directed to refer standard textbooks of medicine and authentic online resources such as Medscape. While designing the case scenarios, they were asked to follow a template constituting the following elements: Case title, case history, clinical signs and symptoms, laboratory investigations and treatment. They were forbidden to reveal their topic and case scenarios to other groups and instructed not to indulge in plagiarism. Students were given 2 weeks' time for case scenario design, after which they emailed the case scenarios to the faculty, who checked them for plagiarism using 'Turnitin' software. Content errors were discussed with the individual student groups and corrections were made. The case scenarios (**Table 1**) were vetted by a clinician in the institution and the clinician's opinion on the case scenarios was collected using a questionnaire which was prepared and validated by a senior medical educationist in the institution. Thereafter, the case scenarios were returned to the students with instructions to convert them into songs accompanied by music. These case-scenario songs were named 'Diagnosongs', because their purpose was to finally elicit a diagnosis from the participants in the audience. Students were given the freedom to adopt any genre of music, be creative and imaginative.

**Table 1:** Sample case scenarios**Lemony Kid**

- ✓ Roshan, 10-year-old boy, was admitted to the hospital with yellowish discolouration of sclera. History revealed that he was on antibiotics (trimethoprim-sulfamethoxazole) for a respiratory tract infection. His symptoms included fatigue, shortness of breath and brown urine.
- ✓ Dietary history revealed that Roshan had consumed a meal consisting of lentils and fava beans. He was suspected to have hemolytic anemia. His blood test results were as follows:
- ✓ RBC count: 3 million / cubic mm; Hb: 10.5g / 100 ml. Heinz bodies were present in the red blood cells. Liver function tests revealed total bilirubin of 11mg/dl; Unconjugated bilirubin: 8/dl. Urobilinogen in urine: 6mg/day
- ✓ The doctor discontinued the antibiotic and put him on a new one. He was prescribed hematinics. He was advised to stay away from fava beans and was provided with a list of foods and medications to be avoided.

**Diagnosis: Glucose 6-phosphate dehydrogenase deficiency****Tired pale Julie**

- ✓ Julie, a 28-year-old woman, employed as a farm labourer, went to the hospital complaining of generalized weakness and fatigue when doing routine work. She also had experienced periods of dizziness and cramping in her legs. Upon examination, it was observed she had tachycardia, glossitis, pale gums as well as pale coloring of the inside of her lower eyelids. The physician noticed her pale complexion and conducted a physical examination and ordered a blood test.
- ✓ The blood test revealed the results as shown below:
- ✓ Red blood cell count: 3.2 million/mm<sup>3</sup>, hematocrit: 30%, mean corpuscular volume: (MCV): 65fL, mean corpuscular hemoglobin concentration (MCHC): 24%, serum Iron: 30 µg/dL, serum ferritin: 9 ng/mL, hemoglobin 8.5g%.
- ✓ Stool examination revealed helminthic ova
- ✓ Based on the findings of Ba's physical examination and the results of her blood test, she was prescribed albendazole and ferrous sulphate tablets.

**Diagnosis: Iron deficiency anemia****Silent killer in factories**

- ✓ Sajith, a 52-year-old working in a plastic factory, presented to the medical OPD with several weeks' history of nausea, headache, dizziness, confusion and general weakness. He also developed difficulty in breathing during the last few days.
- ✓ On examination, his body temperature was 36°C, pulse was weak with a rate of 92/minute. His pupils were dilated, and he had a red flush on the skin. His breath smelt of almonds.
- ✓ His plasma lactate level was 18mmol/L. (normal 0 - 2.2 mmol/L). He also had elevated methemoglobin.
- ✓ Based on these findings, he was provided with 100% oxygen and treated with hydroxycobalamin.

**Diagnosis: Chronic cyanide poisoning**

The students were given 2 weeks' time to complete the task and report back to the faculty. After this, each group had 2 practice sessions of the 'Diagnosongs' (**Table 2**) under faculty supervision. However, during the practice sessions it was felt that the salient features of the 'Diagnosongs' were not heard clearly while they were being sung. This was a drawback, since the rest of the class had to arrive at a diagnosis when the 'Diagnosongs' were being presented. To bring in clarity, students were instructed to display 2 power point slides along with each song during the presentation. First one would carry the title of the case scenario, and the second would carry the lyrics or the salient features of the case. It was the students' prerogative to decide as to how they would present the case to the audience, requiring synchronization of their singing with the appearance of the lyrics narrating the salient features of the case.

**Table 2:** Sample case scenarios songs constructed by test group students**1. Lemony Kid (Glucose-6-phosphate dehydrogenase deficiency)**

There's a 10-year-old boy  
 Yellowish sclera, brown urine  
 Antibiotics (sulfamethoxazole)  
 Fatigue, shortness of breath, pale skin  
 Fava beans  
 Hemolytic anemia  
 Heinz bodies in RBCs  
 Hemolytic jaundice

RBC count 3m / cu mm  
 Hb count 11g / 100 ml  
 Unconjugated bilirubin 18 mg / dl  
 Conjugated bilirubin 5 mg / dl

There's a 10-year-old boy  
 With recent course of sulfamethoxazole  
 He's fatigued  
 With shortness of breath and always pale

Staple diet of fava beans  
 He's so scared and shocked  
 With yellowish sclera  
 And brown urine

Low red blood cells count  
 Low hemoglobin count  
 Oooooohhhh~  
 Hemolytic jaundiceeeeeee  
 Oh come on guysssssss

This pitiable little boy  
 Has high indirect and direct bilirubin  
 He went to the doctor  
 Found out Heinz bodies

He's weak weak weak  
 And pale pale pale  
 And he will googogogo  
 To the doctor, I mean doctor

There's a 10-year-old boy  
 With recent course of sulfamethoxazole  
 He's fatigued  
 With shortness of breath and always pale

Diet of fava beans  
 He's so scared and shocked  
 With yellowish sclera  
 And brown urine

Oh  
 I will go get the cure and  
 Change my diet ahahah diettt  
 So, what u just wanna doooooo  
 So, let's just get cureeee

If I wake up and gonna be fatigued, that's cool  
 No I won't blame meee  
 I was helplessssss

He's weakkkkkkkk  
 And paleeeeeeee  
 And he will googogogo  
 To the doctor, I mean doctor

## 2. Tired Pale Julie (Iron Deficiency Anemia)

A farm labourer, whose name's Julie,  
 She felt tired, fatigued and weak,  
 She had dizziness, and leg cramps too  
 And she had never, ever, ever felt this way.

She told her mother, but she didn't care,  
 'It's nothing, what are you saying',  
 Said there is also swelling of her tongue,  
 So, she decided to go see the doctor,  
 The Doc' was like,

'Julie, Julie, Julie ooohhh',  
 'Your heart beat's really, really fast',  
 'Your gums and eyelids, pretty pale',  
 'What has happened to you, you?'

'Doctor, Doctor, Doctor, ooohhh',  
 'Tell me, tell me what to do',  
 'Julie, Julie, Julie ooohhh',  
 'Let's take a blood test now, now'.

Her blood test came back, with the results,  
 Her red blood cell count was very low,  
 Hematocrit, 30%  
 And it is never ever normally like this.  
 Julie was shocked, hearing this news,  
 'Oh my gosh, what are you saying',  
 And her serum iron's really low,  
 And this news broke her heart for the first time,  
 And she was like,

'Doctor, doctor, doctor, ooohhh',  
 'What is, what is wrong with me',  
 'Help me, help me, help me please',  
 'Will I be okay, ayy'.

## 3. Silent killer in factories (Chronic cyanide poisoning)

I was 50 when I first saw you  
 I close my eyes and the headache started  
 I'm fainting there  
 Feeling dizzy and so nauseous  
 See the smoke, see the plastic pollution  
 See you make you through the ER and say Hello  
 Little did I know  
 That I was unconscious with difficulty in breathing  
 and my doctor said stay away from pollution  
 and I was crying on the staircase

begging my weakness to go  
 and I had  
 red flush on skin  
 Almond breath and low BP  
 Cardiac arrest, I didn't see this coming  
 You are my doctor, and I am your patient  
 It's a sad story, doctor, please save me  
 They say I have neurological problems  
 Plasma lactate level 18mmol  
 Way too high  
 Methemoglobin pretty high  
 Based on the findings, hydroxycobalamin  
 100% O<sub>2</sub>, will cure me  
 Don't be afraid, we'll make it out of this mess  
 It's a sad story, doctor please save me

On the day of presentation of the 'Diagnosongs', the study design was briefly explained to the audience consisting of the 'test' group students, pre-clinical faculty nominated as judges (n=4) and five other guest faculty. Marks awarded by faculty for each case scenario were based on content, clarity of lyrics, presentation and creativity, amounting to a total of 10. These were converted to a percentage representing each group of students. The marks obtained by each student for the correct diagnosis were converted into percentage. Feedback from faculty (n=9, including the judges and guest faculty), who attended the presentations was collected using a 5-point Likert scale, responses 'strongly agree' and 'agree' were clubbed and are presented as a percentage.

Next, all the case scenarios were emailed to all the students (control and test groups), to enable them to prepare for the MCQ test to assess knowledge retention. This was scheduled for the next week and consisted of 21 questions with 3 questions related to each case scenario (Samples as in Table 3). The MCQs were validated by two senior faculty of the Department of Biochemistry and were loaded on to the LAN network in the digital laboratory using Google forms. The students (control and test groups) were given 45 seconds to answer each MCQ, with each correct response fetching 1 mark and with no negative marking. The scores obtained were divided into 4 categories, i.e, 75% and above as distinction, 65% to 74% as first class, 50 to 64% as pass and below 50% as fail.

The results of the MCQ test were analyzed for statistical significance by calculating 'p' values, with  $p < 0.05$  being considered as significant. A questionnaire consisting of 16 items on a Likert scale, addressing different aspects of critical thinking, learning and the conduct of the activity was designed and validated by a senior medical educationist of the institution. This was used to collect feedback from the students in the test groups in the digital laboratory using Google forms and the data was presented as percentage. Last of all, an informal discussion regarding any specific difficulties encountered by the students during the activity was held, with a view to improving the outcomes when the activity would be repeated.

**Table 3:** Sample MCQs related to sample case scenarios

<b>Glucose-6-phosphate dehydrogenase deficiency</b>	<b>Iron deficiency anemia</b>
<p><b>1. Triggers for precipitation of symptoms of glucose 6- phosphate dehydrogenase deficiency include which of the following?</b></p> <p>Glutathione Bilirubin Trimethoprim * Vitamin B6</p>	<p><b>1. Which among the following is a cause for iron deficiency anemia?</b></p> <p>Hyperchlorhydria Repeated blood transfusions Hook worm infestation* Increased intake of vitamin C</p>
<p><b>2. Which among the following is the most characteristic feature of G6PD deficiency?</b></p> <p>Low RBC count Low Haemoglobin Heinz bodies in RBCs* High total bilirubin</p>	<p><b>2. Which among the following blood indices corresponds to the one seen in iron deficiency anemia?</b></p> <p>High mean corpuscular volume High corpuscular haemoglobin concentration Low serum ferritin* Low TIBC</p>
<p><b>Chronic cyanide poisoning</b></p>	
<p><b>1. Which among the following is a clinical feature of cyanide poisoning?</b></p> <p>Decreased blood lactate Bradycardia* Acetone breath Metabolic alkalosis</p> <p><b>2. Which among the following justifies treatment of cyanide poisoning with hydroxycobalamin?</b></p> <p>Prevents binding of cyanide to complex IV of respiratory chain Helps in excretion of cyanide as cyanocobalamin* Promotes ATP synthesis Prevents uncoupling of electron transport and oxidative phosphorylation</p>	

Note: \* represents the correct answer for the MCQs

## RESULTS

Based on 'Turnitin' analysis, the extent of plagiarism in the case scenarios designed by students was found to be 5%. The opinion of the clinician who vetted the case scenarios (**Table 4**) shows that the case scenarios constructed by all 7 groups were according to the template provided and all the case scenarios were of an appropriate difficulty level for undergraduate medical students.

**Table 4:** Opinions of the clinicians regarding the case scenarios.

Attributes of case design <i>per se</i>	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)
1. Cases were constructed based on guidelines given viz, case title, case history, clinical signs and symptoms, laboratory investigations and treatment.					7
2. Title was relevant to the case.			2	2	3
3. Case history, clinical signs and symptoms, laboratory investigations and treatment aspects were well correlated with each other.		1	1	2	3
4. Problems designed had suitable clarity.			2	3	2
5. Problems were of an appropriate difficulty level for undergraduate medical students.					7

During the presentation of ‘diagnosongs’, 6 groups used progressive disclosure of the salient features of the case when singing along with the slides. The group which presented ‘Chronic cyanide poisoning’ adopted a unique method using Adobe Flash and synchronized the singing with the lyrics, which proved to be the most effective way of communication. It primarily enhanced the intelligibility of the lyrics and was appreciated maximally by the audience. This group also got the highest score (93%) for their presentation (**Table 5**). Majority of students (80-98%) were able to diagnose the cases based on the presentations of the ‘Diagnosongs’, (**Table 5**).

The faculty who witnessed the case scenario presentations agreed that the activity improved critical thinking (100%), activated prior knowledge (100%), promoted integration of concepts between subjects (100%), increased motivation to learn (100%). They also opined that the activity improved peer-assisted learning (100%), promoted creative thinking and active learning (100%) and made learning enjoyable (100%) (**Table 6**). Sample questions from the MCQ test are shown in **Table 3**.

**Table 5:** Marks obtained by each test group in diagnosing each case and marks awarded by faculty for presentation.

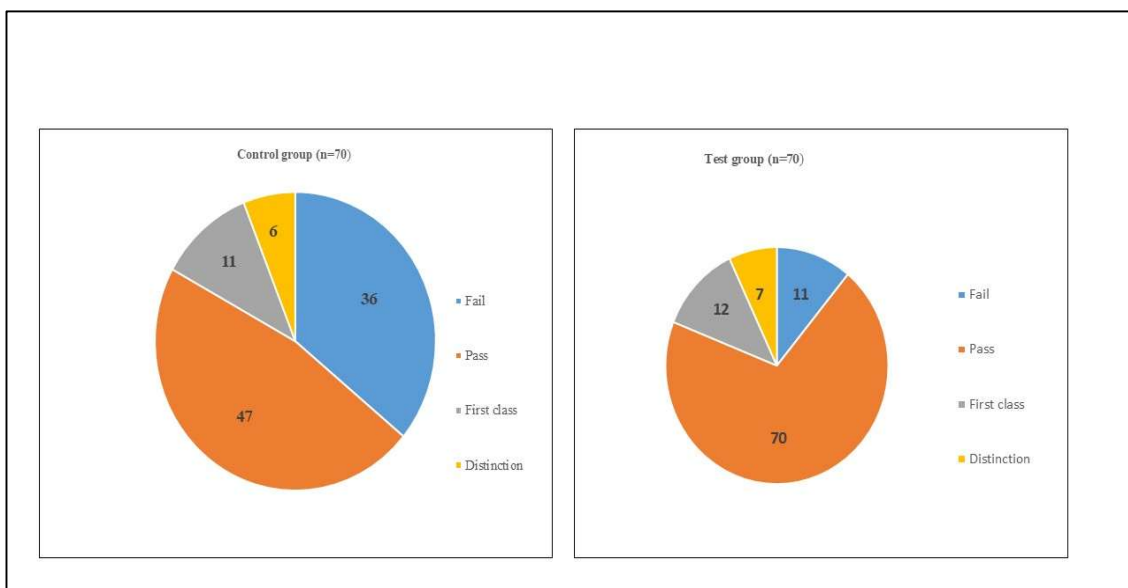
Group number	Topic chosen	Title given by students to the case scenario	Percentage of marks obtained by the groups for presentation of case scenarios as assessed by faculty	Percentage of students who could arrive at the correct diagnosis
Group 1	Peptic ulcer due to over secretion of gastric acid	Down the Gastric Hole	86	96
Group 2	Glucose-6-phosphate dehydrogenase deficiency	Lemony Kid	81	98
Group 3	Iron deficiency anemia	Tired Pale Julie	83	97
Group 4	Multiple myeloma	Rohan's refractory trouble	74	90
Group 5	Obstructive jaundice	Sunflower woman	84	88
Group 6	Chronic cyanide poisoning	Silent killer in factories	93	80
Group 7	Myocardial infarction	Jim's unhealthy habits	73	91

**Table 6:** Feedback from faculty who attended the presentations

Please express your opinions on the following attributes of the activity	Sum of agree and strongly agree responses expressed as percentage (%)
1. Increased knowledge	86
2. Improved critical thinking	100
3. Activated prior knowledge	100
4. Increased integration of concepts between different subjects of the pre and para clinical years	100
5. Improved clinical orientation	86
6. Improved motivation to learn	100
7. Promoted self-directed learning	71
8. Promoted collaborative learning	86
9. Increased peer-assisted learning	100
10. Promoted creative thinking	100
11. Promoted active learning	100
12. Made learning enjoyable	100

Analysis of the MCQ test results (**Figure 2**) for students revealed that the activity had enabled a significant improvement in pass percentage ( $p < 0.001$ ), while the number of students who secured a first class or distinction remained almost constant. As evident from **Table 7**, students felt that the activity activated prior knowledge (75%), improved collaborative learning (74%) and enhanced creative thinking (73%). They opined that the activity also increased active learning, clinical orientation, increased integration of concepts between subjects (70%) and reduced stress (85%).

Students were also engaged in an informal discussion during which they revealed that they did not have any specific difficulties in case scenario construction. When asked about their individual contribution to the activity, they said that most of the time the process was guided by their team-leader. They also confessed that it was a welcome reprieve from the daily routine of rigorous medical school training. Though the activity was enjoyed by most of them, a few felt that it was time-consuming.



**Figure 2:** Comparison of MCQ test results between control group and test groups  
Values are expressed in percentage

**Table 7:** Student feedback on the activity ‘Diagnosongs’

Dear students, Please respond to the following statements regarding the activity which entailed design of case scenarios and their conversion to ‘Diagnotunes’	Sum of agree and ‘Strongly agree’ responses in percentage
1. Increased knowledge	69
2. Improved critical thinking	72
3. Activated prior knowledge	75
4. Increased integration of concepts between subjects	70
5. Improved clinical orientation	70
6. Improved motivation to learn	59
7. Increased active learning	70
8. Promoted self-directed learning	68
9. The activity taught us how to work as a team (collaborative learning)	74
10. The activity was enjoyable	69
11. The activity was difficult	25
12. The activity was time consuming	64
13. Composing the song was difficult	53
14. Composing the music was difficult	48
15. The activity made us think creatively	73
16. Activity helped reduce stress	85

## DISCUSSION

The spirit of scientific inquiry and innovation has led to an explosion of information and technology the world over. This has impacted the realm of practice of medicine too, with better modes of diagnosis and treatment. Today, medical specialties and super specialties vie with each other for supremacy and the human touch in the ‘art of healing’ has taken a backseat. In countries with a large population, the burden on the health care system is enormous and often doctors find themselves completely stressed out (Nguyen Ngoc *et al.*, 2020; Bernburg *et al.*, 2016; Cheung *et al.*, 2016). Even so, a doctor attending to patients in such a scenario, is expected to be calm and composed and communicate with the patient effectively. It has been established that creative activities improve self-esteem, stimulate cognitive function, reduce stress and anxiety (Martin *et al.*, 2018).

Thus, to remain relevant as a humane and empathic practitioner of the art of healing in the future, medical students’ exposure to creative activities is of great significance. With a view to addressing these lacunae in medical education, medical humanities (MH) curricula have been introduced in various medical schools in different parts of the world. Experiences with MH programmes have been positive in improving clinicians’ abilities to communicate with patients and developing the ability to deal with patients with psychosocial issues and most of all, improving empathetic behaviour (Ousager and Johannessen, 2010). These activities are known to finally improve the quality and attitudes of medical graduates.

Medical students in the first year in India where this study was conducted, have very few opportunities to learn actively and indulge in a creative pursuit in the company of their peers. This study represents a novel experiment in medical education which blended active learning with creativity. The first-year medical students not only exhibited creativity in designing the case scenarios but also in converting them into ‘Diagnosongs’ and presenting them to an audience. During the process, they not only gained knowledge (as corroborated by the significant improvement in scores in the MCQ test), but were able to collaborate with their peers and synthesize an all-new experience for themselves. Collaborative activity, which enabled the success of this venture, has direct implications in medical practice, since doctors invariably work in conjunction with their superiors and peers (Ambrose *et al.*, 2017; Schmidt, 2015). The highly packed medical curriculum at MMMC leaves only a diminutive window to harness

students' enthusiasm for student-centred creative activities. As such, the activity had to be planned to be navigated through the regular curricular hours, without disturbing the students' schedules. Based on the feedback, most students enjoyed the learning experience, and the positive attributes of the activity were endorsed by both students and faculty. The enthusiasm exhibited by students in taking part in this activity was admirable and encouraging.

## LIMITATIONS OF THE STUDY

The study had to be tailored to suit the available time slots during the curricular hours, which was challenging.

## CONCLUSION

While literature strongly supports the role of active learning in medical education, does creativity have a role to play in enhancing the learning experience and adding a new dimension? The answer is affirmative, since the stakeholders in the present initiative, *i.e.*, the students and faculty, felt that the activity facilitated knowledge gathering, active learning and creative thinking. The significantly better scores obtained by the 'test' group in the MCQ test conducted following the activity, is an affirmation of learning. The student participants also opined that it enabled integration and retention of knowledge. The study corroborates the present view in medical education, which affirms a definitive role for student-centred activities. The enthusiasm exhibited by students throughout the different stages of the activity was exemplary. It is well known that medical students are subject to significant amounts of stress, and the stress-buster attribute of this activity was well appreciated by majority of the students. Engaging medical students in creative activities is also known to encourage out of the box thinking and may have a bearing on them becoming creative problem- solvers. The enthusiastic participation of students, and requests for more such activities is heartening and encourages the faculty to go the extra mile in planning and implementing more innovative strategies in medical education.

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## CONFLICT OF INTEREST

There is no conflict of interest in this study.

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