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A study of stress, depression, and anxiety in secondary school students during COVID-19 lockdown in India by reinforcement learning framework using Q learning algorithm techniques in machine learning

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***Abstract*---**During the lockdown time, schoolchildren experience a variety of psychological difficulties. Stakeholders would be responsible for enlisting mental health specialists to assist in the resolution of such situations. As a result of the epidemic, schooling faces a unique set of challenges. There have been a number of cancellations due to the COVID 19 crisis. It is important for students' mental health to be taken into consideration when a public health emergency occurs. When it comes to addressing this issue, it is advised that the government and schools work together to find a solution. It was the major goal of this study to determine the levels of stress, anxiety, and depression among high school students. Because of their mental health issues, such as stress, worry, and depression, students require specific treatment, according to the report. Using the Q Learning Algorithms, a model-free learning method followed throughout the survey. Based on the survey, it concludes that students experienced a variety of personal issues, such as boredom, sadness, anxiety, discomfort of staying at home, and problems with not meeting with friends, among other things.

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***Keywords*---**Reinforcement learning framework, Machine Learning, Q Learning Algorithm, student psychology.

Introduction

The most infectious disease of the century has been Covid 19. The disease has been named as pandemic, as it is not limited to any state, country or continent but has widely distributed around the globe. The Corona virus disease caused by SARSCOV2 has affected various sectors of economy but the most distressed remains the economically weaker section, women and children [1]. The worst of all has been the education system, and the students in India. Ever since the cases of COVID 19 began in India, the Government imposed nationwide lockdown in late March 2020. Most of the Governments, in India and abroad, closed the educational institutions to make an attempt to contain the spread of the disease [2].

As per reports from UNICEF, 106 countries had implemented nationwide lockdown while 55 countries took way of local closures to prevent the spread of virus in turn affecting 1.725 billion learners [3]. Of late it also developed uncertainty of various exams and cancellation of others making the education system more challenging in this period of crises. School closures would not only affect the students, teachers and their families but it poses questions on readiness of digital learning, compromise in nutrition for children with MDMP, economy of the nation, dropout rates due to permanent closure of few institutions with low budget. Thus, school closure during such period poses challenge to the uninterrupted teaching learning process and in turn leading to massive psychosocial impacts [4].

COVID 19 has infected about 7 million people and has taken toll of life of more than 4,00,000 across the world. Apart from the physical symptoms of COVID 19 there has been serious public mental health. It has worst hit the mental health of students in India. Since mental health and academic achievement are linked according to the researches mentioned, WHO released a set of guidelines regarding mental health during the pandemic. They focused on all the categories including the younger generation which includes the school and college going students along with the health care workers and the elder generation who are the most vulnerable to the pandemic [5]. The psychological issues which accompany this pandemic have rapidly compounded its public health burden. Chronic stress changes the chemical and physical structure of the brain, impairing cognitive skills like attention, concentration, memory, and creativity [6].

The current study tries to understand the various psychological issues in students during the lockdown period. It would be the responsibility of the stakeholders to take help of mental health professionals to overcome such issues [7]. The pandemic has presented unique challenge before education system. In the wake of COVID 19 crises many exams of various state boards, CBSE boards, IB boards, workshops, conferences, sports and other activities were cancelled [8]. We built a table called Q-Table which has the dimensions S x A, where S and A are the number of psychological states of the students and actions, respectively.

For every state, there are actions and the likeliness of choosing a particular action depends on the values in Q-table called state-action value.

Students' mental health is greatly affected when faced with a public health emergency, and they need attention, assistance, and support from the community, family, and tertiary institutions. It is recommended that the government and schools should collaborate to solve this problem in order to provide crisis-oriented psychological services that are of high quality and timely to students.

Background

Researchers [9] examined the effects of stress, anxiety, and depression on Chinese nationals during Covid 19. During pandemics, Kousoulis *et al.* [10] stated that mental health issues should be taken seriously. Indians' anxiety level during Covid-19. While stress is a typical reaction to everyday demands, it may become harmful if it interferes with day-to-day activities. "Examination stress" is a perceptual phenomena characterized by Cox as the result of an individual's inability to cope with the expectations put on them by exams. Because of factors including availability of electrical equipment, constant power supply, and internet connections, the impact of online education has been minimal [11]. The influence of the COVID 19 epidemic on local Chinese inhabitants' mental health and quality of life was investigated [12].

Approximately 120 million schoolchildren and teenagers throughout the world have been infected with COVID 19. It is estimated that more than 32 crore pupils in India are affected. A total of 14 crores of elementary and secondary school children in India are affected, making them the most afflicted levels in the country [13]. Since the commencement of Covid 19 in Australia, there has been a correlation between psychological discomfort and changes in health behavior [14]. Student anxiety during Covid 19 is on the rise due to bad economic conditions and lack of technical infrastructure, which affects their academic performance [15].

People's natural inclination to be sociable has been curtailed by this epidemic, especially teens who like going to the mall, going to the movies, and hanging out with their pals [16]. Current online learning has opened the door for digital learning [17].

Hypotheses and Tools for Analysis

Based on the above studies, the following questions arise:

(1) What is the level of depression, anxiety and stress among secondary school students during the 1st wave of COVID?
(2) Is there any difference in their level of depression, anxiety and stress among secondary school students during the 1st wave of COVID?
(3) What are the problems faced by them in studies, faced in families and in their personal life?

With these questions, a set of hypotheses were framed as follows:

(1) There is no significant difference between the level of Depression among secondary school students between the 1st wave and 2nd wave of COVID.
(2) There is no significant difference between the level of Anxiety among secondary school students between the 1st wave and 2nd wave of COVID.
(3) There is no significant difference between the level of Stress among secondary school students between the 1st wave and 2nd wave of COVID.

Sample

The population of study is Secondary school students of Grade 9th and 10th from English medium schools of Navi Mumbai, India which are aided and unaided schools of SSC board. Students were selected randomly from these schools. The data were collected twice during May 2020 i.e., first wave of COVID, a total of 218 students participated in the survey. Of the total participants 138 boys and 88 girls took part in the study. During May 2021, i.e., second wave of COVID, a total of 276 students participated in the survey. Of the total participants 136 boys and 140 girls took part in the study. The students are from lower middle class and middle-class families. Stratified Random sampling was used.

Method

The study during the first wave was carried out between 10th May 2020 to 15th May 2020. While the study during the second wave was carried out between 18th May 2021 to 21st May 2021. An Questionnaire was given to the students with the consent of the officials through online platforms. The data were analyzed and inferences were made with regards to DASS standardized score [18] using reinforcement learning framework using Q learning algorithm techniques in Machine Learning [19,?].

Quantitative as well as qualitative approach was used for this study. Survey and Comparative type of research was used. For the qualitative purpose, Thematic analysis was done for the qualitative data analysis.

Tools for Analysis

The Depression, Anxiety and Stress among the students was studied using DASS [18]. The DASS is a set of three self-report scales designed to measure the negative emotional states of depression, anxiety and stress. The responses were collected on a 4-point rating scale ranging from 0 “didn’t apply to me at all” to 3 “Applied to me very much or most of the time”. The DASS was constructed not merely as another set of scales to measure conventionally defined emotional states. The following steps were followed in developing the Q-learning Algorithm for the analysis.

(1) Initialize Q for all states and actions.
(2) For N episodes, follow steps from 3–9:
(3) Initialize state, S.
(4) Follow the steps from 5-8 for each step of the episode
(5) Choose an action A, from state S, with some policy derived from Q
(6) Now take action, A and get new state S’ and reward R.

(7) For S and A, update the Q value from the above equation
(8) Set S = S', as the current state
(9) Terminate if the state S is the terminal.

The Q-values were updated with the following equation

$$Q(S_t,a_t) \leftarrow Q(s_t,a_t) + \alpha(r_{t+1} + \gamma \, max \, Q(s_{t+1},a) - Q(s_{t+1},a_t)) \qquad (1)$$

Where the previous state and action are s(t) and a(t) and s(t+1) and r(t+1) are the current state and reward. The learned value is the target and the old value is the prediction and the difference between them is the error. We then fix the old value using error with the learning rate.

Analysis and Interpretation

In this section, we study the levels of depression, anxiety and stress during the 1st wave and 2nd wave separately. Then, we compare these levels. Finally, trying to understand the problem faced by students related to studies, family and personal life during the Corona phase.

First wave - started Feb 2020

Depression

During the 1st wave of COVID, more than half of the students i.e., 54.84% students were in Normal range. But the remaining students were in Mild to extreme severe range. Though the number of students in severe and extremely severe range was very low but cannot be ignored. Around 38.71% students were in the mild and moderate range of depression. Similar pattern was seen in case of girls and boys. Boys seem to be more vulnerable to depression as compared to girls. The data has been tabulated in Table 1.

Anxiety

During the 1st wave of COVID, the level of anxiety in the students from mild to extremely severe was about 73.27%. It is observed that only 26.73% students had

Table 1. Depression levels during COVID - 1st wave

Level	Students, %	Girls, %	Boys, %
Normal	54.84	61.36	50.39
Mild	17.51	17.05	17.83
Moderate	21.20	15.91	24.81
Severe	04.61	03.41	05.43
Extremely Severe	01.84	02.27	01.55

Table 2. Anxiety levels during COVID - 1st wave

Level	Students, %	Girls, %	Boys, %
Normal	26.73	32.95	21.71
Mild	10.60	10.23	10.85
Moderate	16.59	21.59	13.95
Severe	16.13	10.23	20.16
Extremely Severe	29.95	25.00	33.33

Table 3. Stress levels during COVID - 1st wave

Level	Students, %	Girls, %	Boys, %
Normal	67.74	73.86	63.57
Mild	11.98	10.23	13.18
Moderate	13.82	10.23	16.28
Severe	05.07	04.55	05.43
Extremely Severe	01.38	01.14	01.55

anxiety levels in the normal range. About 60+% of the students were found between moderate level of anxiety was higher in girls but severe to extremely severe level values were greater in boys than girls. The increased level of anxiety is a matter of concern. The data has been tabulated in Table 2.

Stress

During the 1st phase of COVID, the levels of stress amongst students in the normal range were about 67.74%. However, 32.26% students were in the range of mild to extremely severe which cannot be neglected. About 20.27% students had stress level in the range of moderate to extremely severe as tabulated in Table 3. Boys were found to be more susceptible to stress than girls.

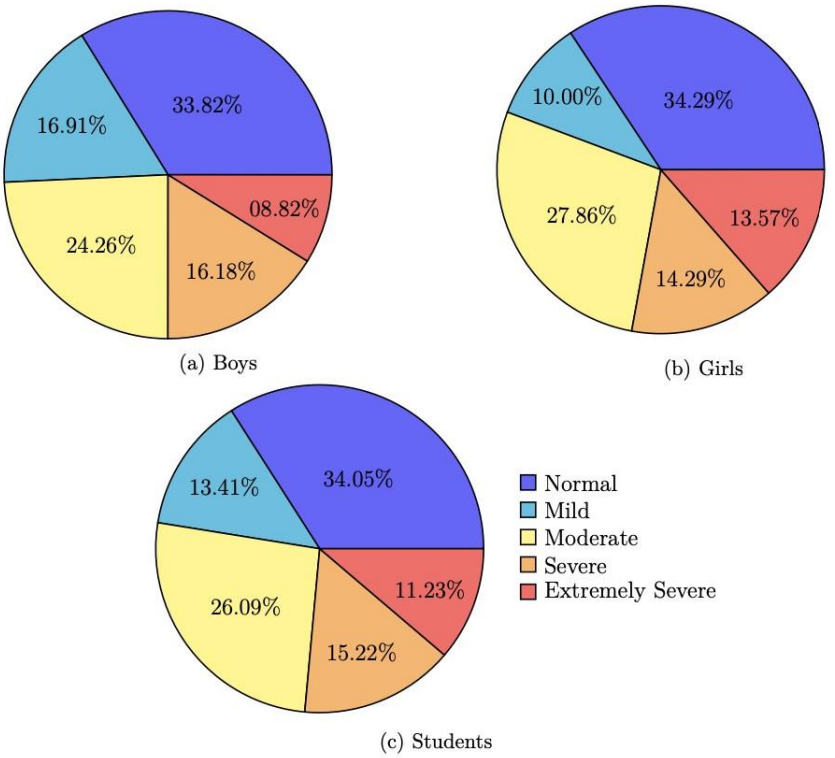

Fig. 1. Depression levels during COVID – 2nd wave

Second Wave - started Mar 2021

Depression

During the 2nd wave of COVID, about 34.05% students were found to be in normal range of depression which was much lesser than 1st wave. The depression level among students from mild to extremely severe levels was found to be about 65.95%. This range also showed a spike in the level of depression in comparison to the 1st wave. Also, the level of depression was much more in girls than in comparison with the boys. The data has been shown in Fig. 4.2.1.

Anxiety

The anxiety levels during the 2nd wave of COVID was much more challenging in comparison with the 1st wave as shown in Fig. 2. It was observed that 81.52% of the students fall in the range of mild to extremely severe levels of anxiety. About 54.71% of the students fall in the category of severe to extremely severe levels of anxiety which is a matter of concern. Alone about 40.22% students fall in the category of

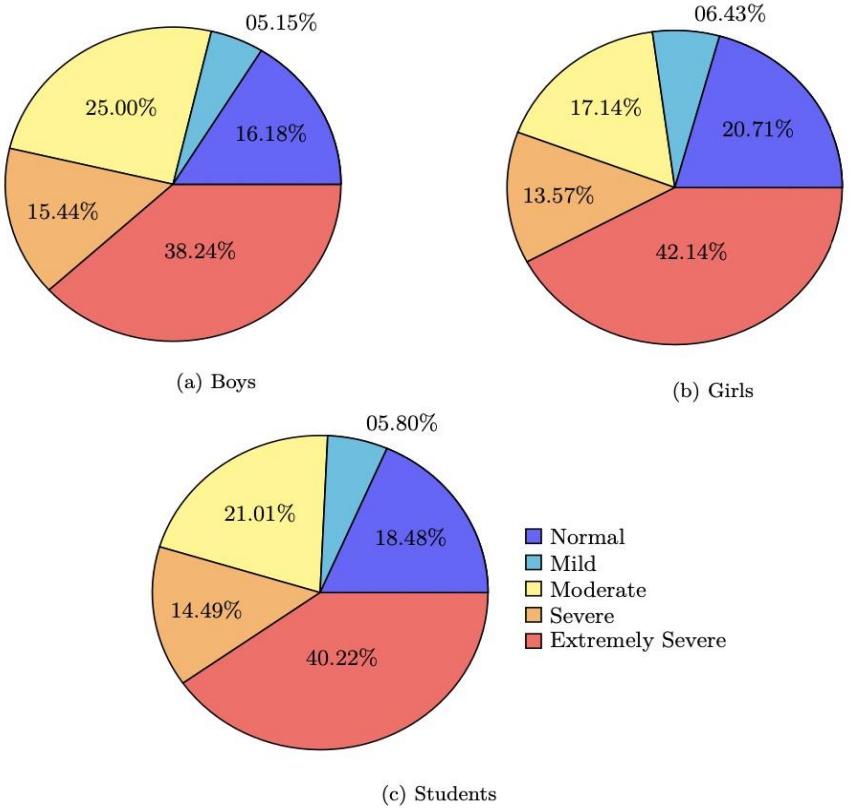

Fig. 2. Anxiety levels during COVID - 2nd wave extremely severe levels of anxiety. Anxiety levels in girls was greater than boys.

Stress

The second COVID wave revealed that 56.16% of children were experiencing mild to extremely severe stress. 43.84% of students had normal stress levels, but the other kids had to be taken into account. About 22.83% of pupils had stress levels that ranged from moderate to severe. In terms of stress, both boys and girls had similar levels. The data has been represented as pie chart in Fig. 3.

Comparison of data between First and Second wave

To check if the depression level, Anxiety level and Stress level of the students differ during first wave and second wave of corona, we applied the T-test for independent samples. Table 4 shows the mean, standard deviation, calculated t-value and the

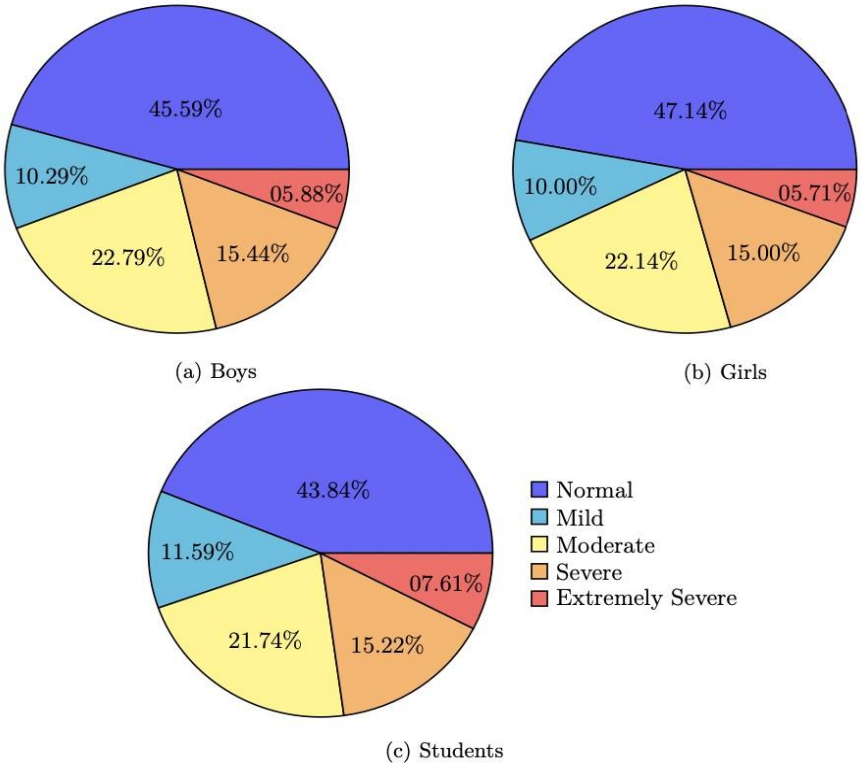

Fig. 3. Stress levels during COVID - 2nd wave

Table 4. Level of significance using T-test

Variable	1st wave		2nd wave		Calculated t-value	Level of Significance
	Mean	SD	Mean	SD		
Depression	9.96	7.08	14.88	9.51	6.36	0.1%
Anxiety	14.59	9.67	18.01	11.22	3.57	0.1%
Stress	11.76	8.39	17.56	10.76	6.53	0.1%

level of significance.
Since the calculated value of t for all variables viz., depression, anxiety and stress is greater than the table value (3.32) at 0.1% level, the null hypothesis is rejected.

Interpretations

It can be clearly observed that the level of depression (extremely severe level) among students have increased rapidly during the 2nd wave of COVID which is almost ten folds. Also there has been a substantial rise in moderate levels and severe level.

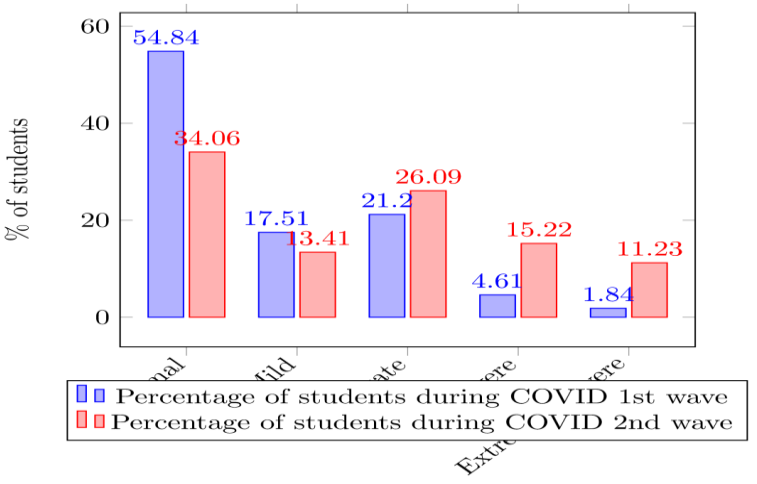

Fig. 4. Depression level of students during 1st wave and 2nd wave of COVID-19 using Q-Learning

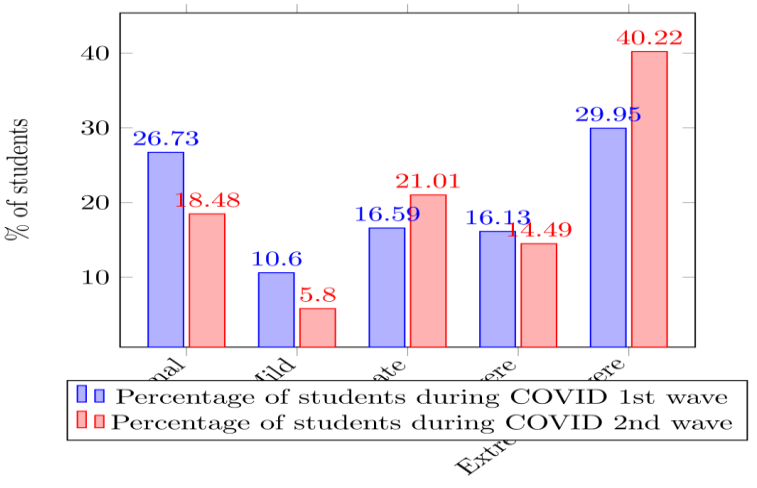

Fig. 5. Anxiety level of students during 1st wave and 2nd wave of COVID-19 using Q-Learning Algorithm

Algorithm

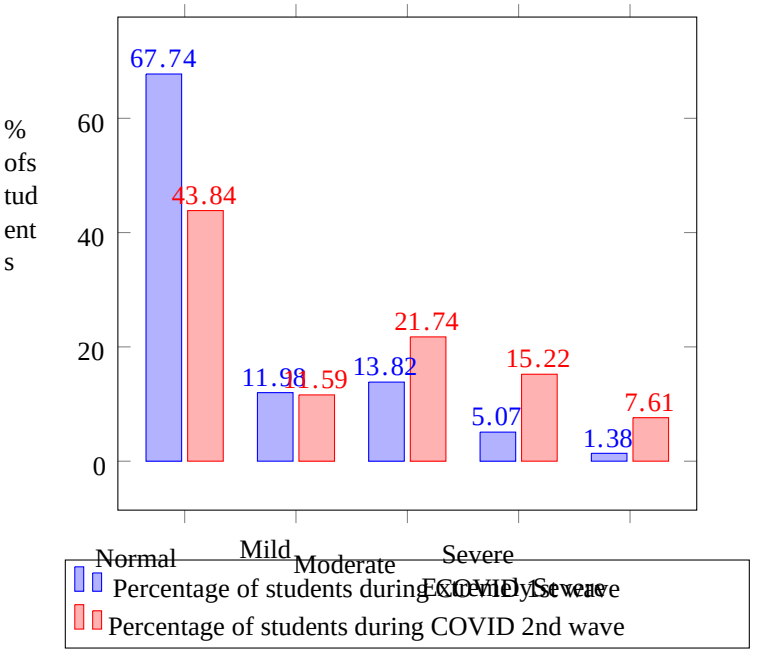

Fig.6.StresslevelofstudentsduringlstwaveandlndwaveofCOVID-19usingQ-Learning Algorithm

Anxiety levels of students during 2nd wave of COVID for Extremely Severe and Moderate levels have increased to a greater extent which also is an alarming signal about the mental health of the students. This is a matter of concern for Government, and other Stakeholders of Education. The Stress level amongst students during 2nd wave of COVID is also a matter of concern as Moderate levels, Severe and Extreme severe levels show a spike rise. The Severe levels in comparison to 1st wave has increased 3 times while extremely severe levels have increased to about seven times.

The purpose of qualitative analysis was to find out the problems faced by students that might have affected their studies during corona phase. For the qualitative analysis, three open ended questions were asked to the students, as follows.

(1) What are the problems you faced during online learning?
(2) What are the problems faced in family during corona phase?
(3) What are the personal problems faced by you during corona phase?

The students' responses were analyzed using thematic analysis method. First of all, the responses under three main categories i.e., problems in online learning, problems faced by family and personal problems faced by students were codified into 14 categories.

Out of the total students who mentioned health issues like strain in the eyes, the count was 54 which constituted about 19.57% of the total population [20]. Another major problem of the online learning was the Internet issues which counted for 139 students which is 50.36% of the population. The difficulty in understanding was a problem for about 49 students that included 17.75%. For the students who needed to have clarity of doubts and to develop better learning experience constituted for about 47 students that included 17.03% of the population. The lack of concentration was one another problems during online learning is 53 which includes 19.20% of the total population [21].

In the various problems that family faced during COVID and online learning, about 137 students reported that they faced financial problems which was 49.64% of total population [22]. 27 students reported that they had fear of losing job which constituted 9.78% of the population [23]. About 18 students of the population studied reported problems of death in the family which includes 6.52% of the population [24]. 58 students reported about various health issues during the Covid crises which included 21.01% of the population.

In the personal problems that students were facing during the pandemic situation about 63 students reported of getting bored which constituted 22.83% of the population [25]. Of the total “no meeting with friends” had the count of 57 which included 20.65% of the population. The “feeling of anxiety” was reported 24 students which constituted 8.70% of the population [26]. Depression was reported by 17 students which included 6.16% of the total population [25]. About 42 students reported “discomfort of sitting hom” as one of the personal problems which included 15.22% of the population [27].

Discussions

The main objective of the present research was to study the levels of stress, anxiety, depression among students. The data were collected from secondary school students. Levels of stress, anxiety and depression from extremely severe to normal and mild range were studied. Also, during 2nd wave, open ended questionnaire was shared to the students through the online platform which provided information about various problems the students and family faced during the pandemic. This brought forth the various problems that the students faced during pandemic like health issues like eye strain and headache, Internet issues, difficulty in understanding, lack of clarity of doubts and concentration.

During lockdown situation, students developed more anxiety as a result of fear of getting infected, losing their near and dear ones. Also, few students found it difficult to continue with their daily chores and also few of them felt no excitement in doing things that they liked before. The present study would be of great importance in understanding the psychological problems like stress, anxiety, depression [5].

The students faced various personal problems which mainly included getting bored, no meeting with friends, discomfort of sitting at home, anxiety, depression, etc. Also, the pedagogy of learning for offline mode using chalkboard method does not suffice the need of online mode thus creating stress in students about their

academic performance. Mostly the gifted learners are facing such issues. Since the students have psychological stress, it needs to be addressed to mental health professionals. It was quite clear that students who lack basic facilities for online learning were the worst sufferers. The depression level among students was one of the reasons which could affect their academic achievements.

Most of the schools and colleges have switched over from traditional face to face learning to online mode during the pandemics so that the education continues unhampered. However, the digital learning is yet a great challenge for most of the people for low middle income groups in a developing country like India. Approximately 73.3% of the population of India is connected by mobile phones [28] but yet the use of digital technology is not much studied.

In the Service Sector, Internet is slowly making a headway in both urban and rural areas of the country. Also, in most of the cases the learning for students using various digital portals requires the use of laptop/computer, which again is a serious challenge for the students of middle and low middle class economy. As per the statistics National Sample Survey, 2017-18, 24% of the population have Internet facility and 8% in the age category from 5 to 24 years have both Internet and Computer [29]. Lack of resources is one of the most prominent reason for the stress amongst students as it would not only be difficult to attend online class but also submission of assignments and other online activities and this would result in lacking behind in academic achievements and proper completion of curriculum. As a result, the stress, anxiety and depression level severely increase in the students as they become apprehensive of their future [30].

One of the leading Newspaper [31] reported about 15-year-old girl who committed suicide for being unable to access online classes from her village. A similar incidence also caught attention when a 50-year-old farmer committed suicide as he was not in a position to buy a smart phone for his daughter [32]. Such incidents a great example where the basic education becomes difficult for the students during crises. This would surmount to severe mental health problems further leading to low academic achievement for the students either due to socio economic barrier or geographical barrier. Lack of these facilities is a bane for those underprivileged students who are aiming high to achieve in life. However, on the other hand those who are privileged enough to get the benefits of digital learning with the necessary infra structure is misusing it by wasting time on social networking sites, gaming zone, etc., which also needs intervention for the psychological health of the adolescents
[33].

For the proper participation in education mental and emotional health of the students is of prime importance. The survey reports according to OECD showed that assignment, classwork and examinations had inverse variation to the academic performance in Science, Mathematics and reading. Even though the students were quite prepared but still about 63% students felt anxious about preparation in science subject [34]. Thus, it was inferred that more stress is associated with poor academic performance. Academic-related stress and burnout includes exhaustion, depersonalization or reduced accomplishment. The decrease in academic motivation was a result of Academic-related stress [35].

The education system of our country is based on examination. The children are constantly under tremendous pressure about their report cards, assignment to be completed, class test, etc. Anxiety level of the students increases as the expectation level is high from parents, teachers, school and society at large. A negative relation exists between general anxiety and academic achievement and test anxiety and academic achievement [36].

The pandemic that started in March 2020 in India began with public health crisis but soon it took over to humanitarian crisis. This could be resolved by considering social welfare measures. To decrease and curb the effect of disease, the lock down and restrictions were imposed which severely affected the education sector in India. Various governmental organizations from primary to university level are working to bring about a congenial platform in digital learning which is the need of the hour amidst COVID. National Repository of Open Educational Resources (NROER), Digital Infrastructure for Knowledge Sharing (DIKSHA), e-Pathshala and a National Online Education platform called SWAYAM (Ministry of Statistics and Programme Implementation, 2017–2018) [37]. Various suggestions were made to make education inclusive and accessible to every student of the country. These included:

(1) to develop competent teachers for online mode of learning
(2) weaker and underprivileged section care needs to be taken
(3) improving of infrastructure in mainly geographical inaccessible areas.

Conclusions

The anxiety levels of students were found to be high. Also, depression was found considerable among the students. The present study is important in understanding levels of stress, anxiety and depression. The research finding indicates that students need special attention due to their aspects of mental health like stress, anxiety and stress. The government and other stakeholders of education should make efforts to provide necessary facilities for providing uninterrupted digital learning. Also, the mental health of the students can be taken care by intervention techniques of Yoga and meditation. Thus, the curriculum framers, policy makers, educational stake holders along with the government should make meditation as an important method to overcome such psychological problems. The study conclusively indicates that there had been various personal problems in the students like getting bored, depression, anxiety, discomfort of sitting at home and problems of not meeting with friends. Also, parents of these students also faced various problems at financial front, fear of losing the job, deaths in family and health issues in family.

The various parameters used in this psychological studies on student behaviour and their cognitive patterns were predicted with higher accuracy. Therefore, this algorithm is being recommended for analysing the psychological behaviours and related studies.

Suggestions

Yoga intervention brings about positive effect on factors like emotional balance, attention control, cognitive efficiency, anxiety, negative thought patterns. Apart

from this concentration, self - regulation, attention, stress etc. are also known to be positively affected [38]. Due to all this, a substantial and deliberative interest has started emerging for introducing Yoga interventions activities in schools. Researchers have found that self-regulation and pro-collective behavior which will lead to enhancement in students' behavior and performance, are enhanced with the practice of Yoga [39]. As per a review of survey of School based Yoga programs in U.S, 36 programs were identified in more than 940 schools that offer yoga by more than 5400 instructors have been trained by this program [40]. Thus, considering to the present scenario of COVID 19 and to sustain the mental health of the student's yoga can be looked upon as an important alternative.

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