



Impact of the COVID-19 Pandemic on Learning: Assessing Cognitive, Affective, and Psychomotor Skills

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Research Article

Abstract

The acquisition of cognitive, affective, and psychomotor skills is highly important for successful learning outcomes. This article aims to evaluate the Three-Domain Model (TDM) of learning (cognitive, affective, and psychomotor) during the COVID-19 online classes for tertiary students in Bangladesh. This current study aims at the psychometric evaluation and validation of tertiary students' learning loss during the pandemic. A survey questionnaire is administered using the Likert scale. The components of the questionnaire are based on the Three-Domain Model reflecting the cognitive, affective, and psychomotor skills of the students. The article informs of the learning loss due to the pandemic while suggesting the benefits of online classes. The major finding of the article is that learners lost their skills mainly related to the cognitive domain during the pandemic due to online classes. However, at the same time, their skills related to affective and psychomotor domains increased. Therefore, recommendations for minimizing learning loss are also provided to guide future empirical work in the post-pandemic era.

Keywords: Cognitive skills, Psychomotor skills, Affective skills, Learning loss, Bangladesh

1. Introduction

Due to the COVID-19 pandemic, educational institutions in most parts of the world were closed to protect lives and contain the outbreak of the virus, and so do the academic institutes (Khan et al., 2021). Since then, numerous initiatives are being launched by governments and tertiary institutions across the world to continue teaching through online activities in light of the pandemic (Chand et. al., 2022; Kabir & Hasnat, 2021). The pandemic has affected higher education institutions to their core (Aristovnik et. al. 2020) and the entire education system has collapsed during the lockdown (Mishra, Gupta, & Shree, 2020). Online learning has become the norm and is challenging to conduct without proper guidelines (Simamora et. al. 2020). The integrity of higher education should not be compromised under any circumstances, and therefore a policy framework is needed to ensure that it functions properly during an emergency (Alam & Parvin, 2021). Online technology is used as an auxiliary form to support the delivery of higher education (Alam & Asimiran, 2021). This has created a challenge across the higher education landscape where teachers switched to remote teaching and different approaches (Gamage et. al. 2020).

The pandemic has had significant consequences on the educational dimension of the world (Sa & Serpa, 2020). Due to the special conditions being experienced as a consequence of the pandemic, higher education will face unexpected challenges (Antonopoulou et. al. 2021) and policymakers in higher education will need to plan for the possible implications (Blankenberger & Williams, 2020). The implications for higher education students are significant (Karakose, 2021) and the policy push in higher education toward online teaching and learning was to bring online education to the forefront of academia (Tesar, 2020). Different countries have introduced a number of options to continue education during the pandemic (El Firdoussi et. al. 2020). In practice, higher education institutions are keen to maintain their key activities during the pandemic (Nandy, Lodh & Tang, 2021) and the pandemic has required faculty and students to rapidly transition to distance learning through virtual classrooms (Neuwirth, Jovic & Mukherji, 2021). Online learning promotes the continuity of the education process and coordinates the learning process during the pandemic (Abumalloh et. al. 2021). Technology is one of the most important resources for the promotion of online learning when learners are away from classrooms (Rizvi & Nabi, 2021).

As far as the impact of the COVID-19 closure on in-person education, rapid technological developments in digital education facilitated the adoption of online content in higher education institutions, and the agility of online learning came into focus (Stevens et. al. 2021). The pandemic facilitated the rapid diffusion of digital technologies among the general population (Vargo et. al. 2021) whereas it also highlighted the challenges and opportunities in teaching and learning activities (Peimani and Kamalipour, 2021) since the stakeholders are not always prepared to address the rapid need to change and shift (Lin & Johnson, 2021).

Among all types of learning skills, students' acquisition of cognitive, affective, and psychomotor skills is highly important for effective learning. However, these skills are affected by the pandemic due to virtual learning challenges. These three levels of skills are known as the Three-Domain Model (TDM) of learning. This TDM further leads to a breakdown of skills related to each domain. As far as the Cognitive Domain is concerned, it is the one where the student's cognitive activities are structured. Similarly, Affective Domain is another domain of learning that describes the attitudes of the student toward the subject matter, education, and learning activities. Finally, Psychomotor Domain is especially important for learning by doing through physical activities. It describes the coordination between the student's brain and body (Padugupati et. al., 2018).

While the literature points towards the necessity of online delivery to teaching and learning (Adedoyin & Soykan, 2020; Ali, 2020; Bhagat & Kim, 2020) a number of studies also highlight the negative impacts of education's online transition (Antonopoulou et. al. 2021; Aristeidou & Cross, 2021; Drane, Vernon & O' Shea, 2021; Sahoo et. al. 2021; Senel & Senel, 2021; Tamrat, 2021).

Several research findings highlight that due to this teaching-learning shift, the acquisition of students' cognitive, affective, and psychomotor skills has been affected highly. However, to date, apart from some (Shrestha, et. al., 2022; Khan et. al., 2020; Khan et. al., 2021; Ela, et., 2021) qualitative and mixed-method research reports from the Bangladeshi context, the authors have found insufficient quantitative evidence of the impact of COVID-19 on students' academic learning. In this paper, the authors intend to address this research gap by examining the effects of the COVID-19 pandemic on the effective learning of students due to online education. This rationality gives rise to the following questions:

1. To what extent students' cognitive skills have been affected by the pandemic?
2. To what extent have students' skills related to the affective domain diminished?
3. To what extent is the impact of virtual classes on students' psychomotor skills during the pandemic?

2. Literature Review

Learning is an integral part of every individual's life. It is very key to growth and development and hence requires the need for both students and teachers to be committed to the process. Domains of learning initially developed between 1956 and 1972, the domains of learning have received considerable contributions from researchers and experts in the field of education to measure learning outcomes (Padugupati et. al., 2018). Studies by Benjamin Bloom (on the cognitive domain), David Krathwohl (affective domain), and Anita Harrow (Psychomotor domain) have been encompassed into the three domains of learning (Sousa, 2016). Developing and delivering lessons by teachers are integral to the learning outcomes of the learners. It is hence important for teachers to ensure that the three (3) domains of learning which include cognitive (thinking), affective (emotions or feeling), and Psychomotor (Physical or kinesthetic) are achieved (Sousa, 2016). Considering both the possible positive and negative effects of online education on students, it can be claimed that how students perceive online education might be an important factor related to their learning outcomes (Ogel-Balaban, 2022). The Theoretical Domains Framework (TDF) is an integrative framework developed from a synthesis of psychological theories as a vehicle to help apply theoretical approaches to interventions aimed at the impact of the pandemic on learning outcomes during online education.

This study provides insight into how the TDF was operationalized, used, and experienced by the tertiary students to show evidence-based changes in their learning loss due to online settings. The findings highlight that the TDF is considered a useful approach providing a systematic, comprehensive, and theory-derived process to identify barriers and enablers to online education or change of students' learning mode that can help identify the issues for learning loss if happened during the online education for the COVID-19 closure. However, challenges remain regarding the comprehension and independence of domains and how best to use findings to direct learning activities in the post-pandemic situation.

3. Theoretical framework

Learning helps develop an individual's attitude as well as encourages the acquisition of new skills. So, learning theories are essential to developing educational teaching methods, and so does learning measures. Therefore, to measure students' learning outcomes, there exist several models. Three-Domain Model (TDM) is one of them. As far as this TDM model is concerned, it is initially developed between 1956 and 1972 by Bloom (Bloom, 1956). The domains of learning have received considerable contributions from researchers and experts in the field of education. Studies by Benjamin Bloom (cognitive domain), David Krathwohl (affective domain), and Anita Harrow (Psychomotor domain) have encompassed the three domains of learning (Sousa, 2016). Based on Bloom's Taxonomy, the three (3) domains of learning intend to include cognitive (thinking), affective (emotions or feeling), and Psychomotor (Physical or kinesthetic) skills. This study is underpinned by Three-Domain Model (TDM) as its theoretical framework. This article aims to evaluate the three domains of learning (cognitive, affective, and psychomotor) and their benefits in addressing the different learning styles of students.

4. Design of the study

This study adopted a quantitative design and collected data from students through a survey questionnaire. The questions were grouped into three categories using the Likert scale to measure of cognitive, affective, and psychomotor skills of the students after the COVID-19 pandemic (Appendix). The authors collected survey data in person using a printed questionnaire. Having consent, 300 students from the schools of science, commerce, and human science were approached. The authors explained that participation was voluntary and that they would appreciate it if they participated. The authors also assured them that their privacy and anonymity would be protected. The authors made follow-up calls to request returns if they wanted to participate to 'maximize response rate' (Cohen et al., 2017). The authors of the study finally received 274 questionnaires. Of them, 4 were incomplete and therefore eliminated. So, a total of 270

tertiary students were included and analyzed statistically using SPSS. All of them were undergraduate students and they were recruited through snowball sampling.

5. Results

The statistical reliability of the data set for the *Cognitive Domain*, *Affective Domain*, and *Psychomotor Domain* as the Cronbach’s Alpha are respectively 0.747 (>.70), 0.724 (>.70), and 0.712 (>.70). Therefore, the question items on the scale are consistent, reliable, and so does acceptable. Moreover, all the Corrected item-total Correlation values are more than 0.3 for *Cognitive Domain*. So, we can say that each item is coherent with items in the *Cognitive Domain*. And from the Squared Multiple Correlation, we can infer that the variation in the *Cognitive Domain* mostly depends on understanding how to solve problems (Q1) and performing well in solving problems (Q3). Applying online technology more into practice (Q2) plays a little role in explaining the changes in the *Cognitive Domain*. Cronbach’s Alpha if Item is deleted shows that the values for all the items are less than 0.747 which is Cronbach’s Alpha for the scale. So, we did not need to exclude any item.

Moreover, all the Corrected item-total Correlation values are more than 0.3 for *Affective Domain*. So, we can say that each item is coherent with items in the *Affective Domain*. And from the Squared Multiple Correlation, we can say maintaining good rapport with teachers (Q9), exhibiting self-confidence (Q7), and the ability to justify others’ ideas and opinions (Q10) can better explain the variation in the *Affective Domain*. But the scale little depends on the students’ difficulty in reacting positively to the people around them (Q8). And we need not have to exclude any item from the scale as all the “Cronbach’s Alpha if Item deleted” values are more than the Scale Cronbach’s Alpha (0.724). Furthermore, all the Corrected item-total Correlation values are more than 0.3 (apart from Q11). So, we can say that all the items are coherent with the items in the *Psychomotor Domain*. And from the Squared Multiple Correlation, we can infer that the variation in *Psychomotor Domain* mainly depends on the ability to demonstrate physical tasks (Q13), perform well in a group (Q15), and complete writing tasks on time (Q14). And the difficulty of writing on paper for various academic tasks after the Covid pandemic can do little to explain the variation in the scale. In addition to that, “Cronbach's Alpha if Item deleted” tells us that the scale would be more reliable and consistent if we delete item Q11.

Table 1: Inter-Item Correlation Matrix: Cognitive Domain

Items	Q1	Q2	Q3	Q4	Q5
Q1	1.000	.353	.511	.449	.352
Q2	.353	1.000	.246	.299	.299
Q3	.511	.246	1.000	.468	.377
Q4	.449	.299	.468	1.000	.386
Q5	.352	.299	.377	.386	1.000

Table 1 shows that since all the items have an inter-item correlation between 0.3 and 0.8 (except for the correlation of Q2 and Q3) it can be said that the *Cognitive Domain* has a good inter-item correlation.

Table 2: Inter-Item Correlation Matrix: Affective Domain

Items	Q6	Q7	Q8	Q9	Q10
Q6	1.000	.408	.344	.314	.361
Q7	.408	1.000	.290	.458	.407
Q8	.344	.290	1.000	.373	.378
Q9	.314	.458	.373	1.000	.491
Q10	.361	.407	.378	.491	1.000

As almost all the items have an inter-item correlation between 0.3 and 0.8 (except the correlation of Q7 and Q8) we can say that the *Affective Domain* has a good inter-item correlation (Table 2).

Table 3: Inter-Item Correlation Matrix: Psychomotor Domain

Items	Q11	Q12	Q13	Q14	Q15
Q11	1.000	.348	.215	.337	.160
Q12	.348	1.000	.316	.305	.311
Q13	.215	.316	1.000	.511	.541
Q14	.337	.305	.511	1.000	.534
Q15	.160	.311	.541	.534	1.000

Since about all the items have an inter-item correlation between 0.3 and 0.8 (except the correlation of Q11-Q13 and Q11-Q15) we can say that the Psychomotor Domain has a good inter-item correlation (Table 3).

Table 4: Item Statistics: Cognitive Domain

Item	Mean	Std. Deviation	N	% Change
Q1	2.10	1.259	270	-30%
Q2	3.86	1.052	270	28.67%
Q3	2.17	1.169	270	-27.67%
Q4	2.06	1.086	270	-31.33%
Q5	2.16	1.359	270	-28%

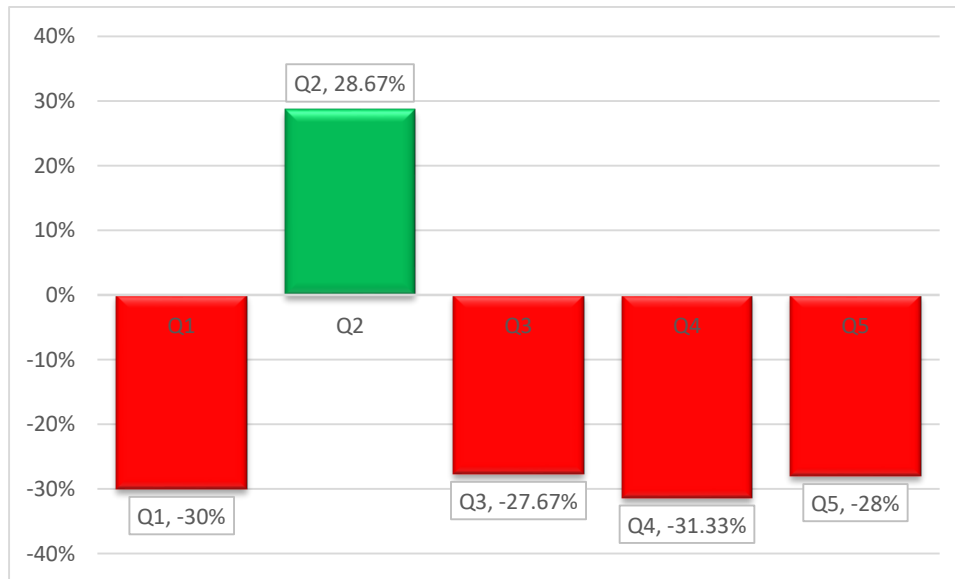


Fig.1: % Change in Cognitive Domain

Note: Green=Improvement and Red=Deterioration

From the Item Statistics of the *Cognitive Domain*, we can say that the items/responses to the questions are consistent as all the Coefficients of Variance are less than 1. Therefore, it further reinforces the findings that the cognitive skills of the students diminished significantly during the pandemic apart from their ability to apply online technology into practice (Q2) which has improved.

Table 5: Item Statistics: Affective Domain

Item	Mean	Std. Deviation	N	% Change
Q6	3.08	1.186	270	-2.67%
Q7	3.10	1.147	270	-3.33%
Q8	2.66	1.085	270	11.33%
Q9	3.28	1.200	270	-9.33%
Q10	3.15	1.141	270	-5%

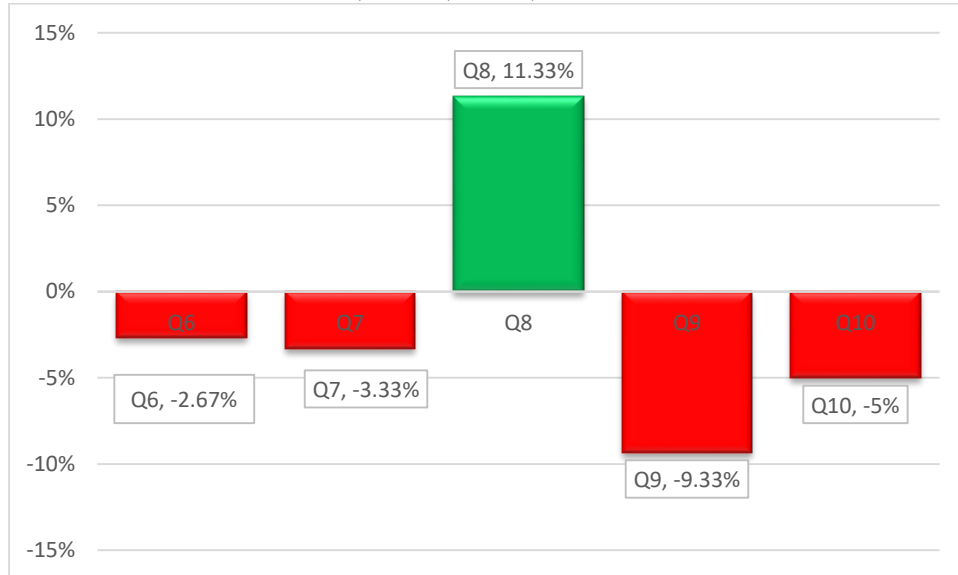


Fig. 2: % Change in Affective Domain
 Note: Green=Improvement and Red=Deterioration

From the Item Statistics of the *Affective Domain*, the questions are consistent as all the Coefficients of Variance are less than 1. Therefore, the findings claim that the affective skills of the students deteriorated very slightly (almost the same). It is interesting to see that now the students feel less difficulty interacting with people around them (Q8).

Table 6: Item Statistics: Psychomotor Domain

Item	Mean	Std. Deviation	N	% Change
Q11	2.76	1.132	270	-8%
Q12	2.77	.986	270	-7.67%
Q13	2.75	1.215	270	-8.33%
Q14	2.89	1.156	270	-3.66%
Q15	3.04	1.151	270	1.33%

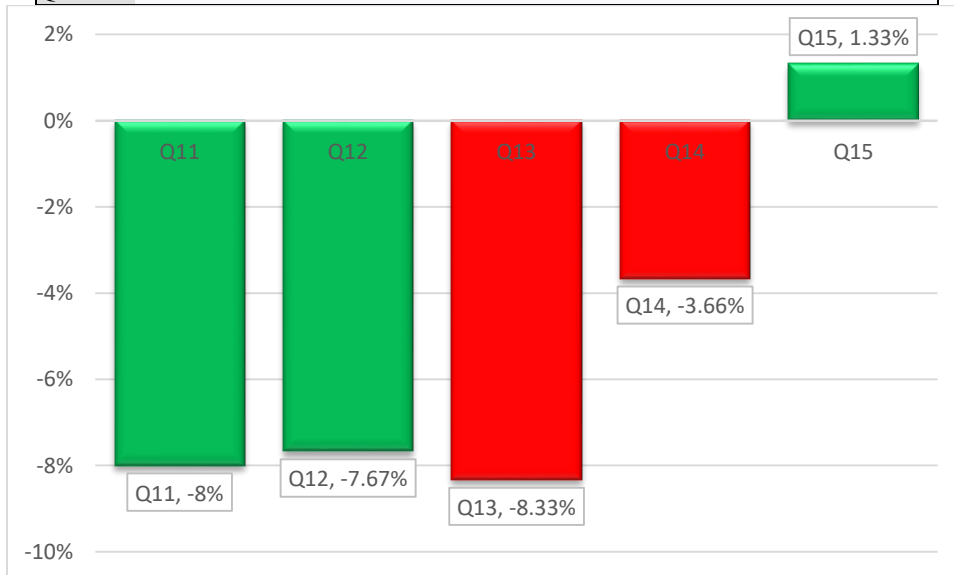


Fig. 3: % Change in Psychomotor Domain
 Note: Green=Improvement and Red=Deterioration

In the case of the *Psychomotor Domain*, the items/responses to the questions are also consistent as all the Coefficients of Variance are less than 1. So, the data firmly shows that students' writing skills and capacity to put academic knowledge into practice have improved a little during the pandemic but their ability to demonstrate physical tasks and complete writing tasks by the deadline has a bit deteriorated. Their teamwork skill almost remains the same as before.

Thus, in summary, we can demonstrate that on average all three types of skills in the Three-Domain Model of the students have deteriorated during the pandemic but not with uniform severity. Students experienced grave loss in their cognitive capacity followed by the psychomotor and affective skills (Figures 4 and 5).

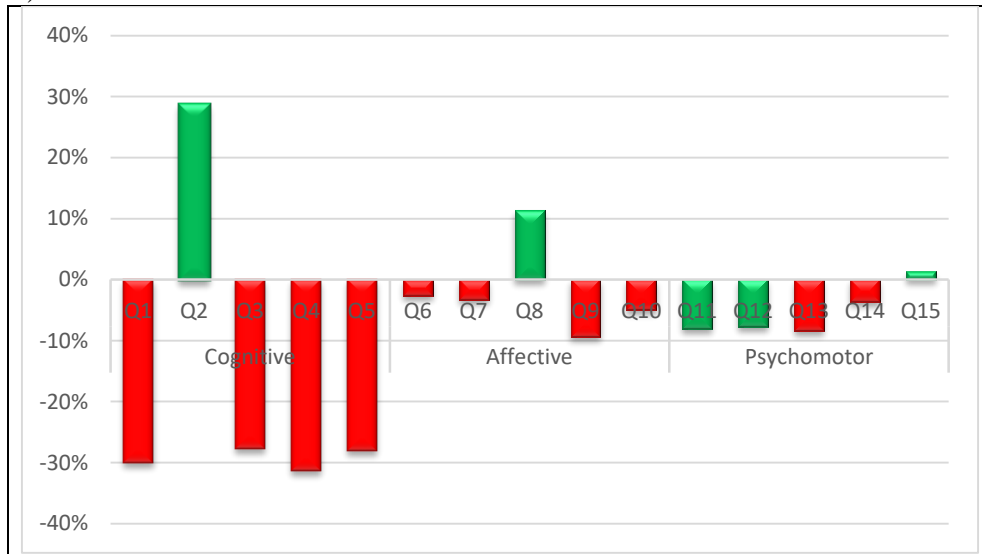


Fig. 4: Students' Learning Loss during the Pandemic through Three Domain Model

Note: Green=Improvement and Red=Deterioration

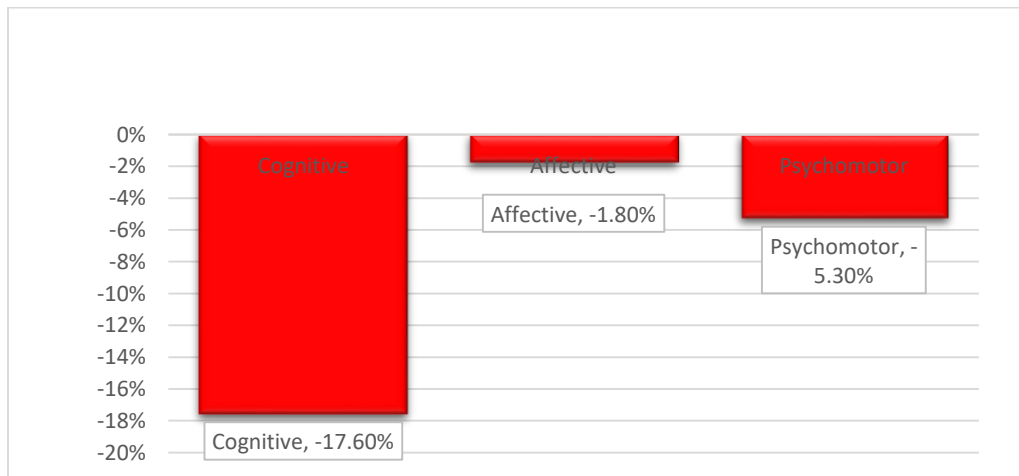


Fig. 5: Average % Change in 3 Domain Model

Note: Green=Improvement and Red=Deterioration

6. Discussion

The present study aimed to examine the influence of the COVID-19 pandemic on university students' learning online. The shift in the education system from the traditional face-to-face system to the virtual platform was one of the major challenges for them during the COVID-19 pandemic. The study presents

some significant changes in the learning domains of all three levels of the TDM model for tertiary students in Bangladesh. Due to their online class during the pandemic, tertiary students lost skills mainly related to the cognitive domain that the authors measured apart from their ability to apply online technology into practice (Figure 1). As they were used to doing online classes, their sense of online technological skills improved. As far as students' affective skills are concerned, it remains the same after the pandemic. However, to our surprise, although they were confined at home, their ability to communicate socially improved slightly (Figure 2). It can be said that virtual connectivity helped them to maintain their social connectivity with their peers and friends during their homestay. It was anticipated that due to the homestay and virtual form of writing for the assignments, students might lose their handwriting skills as a part of their psychomotor skills. Psychomotor skills such as performance-based learning using psychical activities. Some international research (such as Alrashed, et. al., 2021) also avers that due to the lockdown during the COVID-19 pandemic, people lost their efficiency in psychomotor skills. However, in this research, it is found that students could improve their writing capacity.

7. Implications and Conclusion

The findings inform the learning loss due to the pandemic while suggesting the benefits of online classes. It will be helpful for policymakers, teachers, and students. It can be highlighted and stressed with practical measures in post-pandemic new normal situations targeting effective learning resulting in improved TDM skills of students. Finally, it is further necessary to ensure that the TDM model of learning combines generally different facets which have been identified to be the domains of learning. The significance of the study lies in demonstrating that the disruptions to physical and on-campus classes caused by the pandemic, did not have the kinds of dire consequences for students' learning in cognitive, affective, and psychomotor domains that many commentators had anticipated. The findings of this study provide an important counter-narrative to widespread generalized speculation about alarming levels of learning losses due to online classes during the COVID-19 pandemic.

8. Limitations

Findings from one tertiary institute limit the generalizability of important outcomes. We could not collect in-depth qualitative data to measure the actual extent of learning inequalities among the students for social and financial reasons. Moreover, further efforts need to be made to collect data even at the regional level in order to understand the real impact of the pandemic on learners' learning outcomes.

Authors' contributions: S M Akramul Kabir has analyzed and interpreted the data and wrote the discussion section. Mohammad Nayeem Abdullah prepared the theoretical framework. Rahat Bari Tooheen wrote the literature review section and identified the research gaps. Sayeed Hasan did the data analysis.

Conflicts of Interest: The authors declare no conflict of interest.

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Appendix Questionnaire

1. You are able to understand how to solve problems as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
2. You are able to apply online technology more into practice after the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
3. You are able to perform well to solve problems as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
4. You are able to propose innovative ideas for certain academic tasks as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
5. You are able to solve conflicts with your friends as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
6. You are able to listen and share ideas with your classmates as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
7. You are able to exhibit self-confidence as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
8. You feel difficulty reacting positively to people around you as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
9. You are able to maintain a good rapport with your teachers as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
10. You are able to justify others' ideas and opinions as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
11. You feel difficulty writing on paper for various academic tasks after the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
12. You feel difficulty applying related academic knowledge into practice after the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
13. You are able to demonstrate physical tasks as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
14. You are able to complete writing tasks on time as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always
15. You are able to perform well in working in a group with other students as same as before the COVID-19 pandemic.
 Not at all sometimes similar a bit more always