**Detecting Possible Learning Losses
due to COVID-19 Pandemic: An
Application of Curriculum-Based
Assessment**

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Abstract

When the pandemic COVID -19 led to school closures, many of us had no idea that this disruption would last months and perhaps more than a year. Curriculum-based assessment (CBA) is an assessment process that uses academic knowledge picked directly from the material taught in the classroom. This form of criterion-referenced assessment connects evaluation with instructional programs by informing teachers of student progress and learning challenges. In this study a nationwide exam called Transition to Secondary School Exam TEOG Exam was used as a curriculum based tool since TEOG Exam is also second or third exam for semester. The data showed a one and a half year learning loss in both Turkish and mathematics based on Woesmann (2016)`s criteria. The difference in the scores for math exam between 2016 and 2020 was 10.32 points which accounts for half of exam standard deviation. Also, the difference in the scores for Turkish exam 2016 and 2020 was 10.91 points which is also around half of the standard deviation. Additionally, based on gender there was a statistically significant decrease of 12.04 points in the mathematics scores of girls and 8.43 points for boys showing a 15-month learning loss for girls. and a year of learning loss for boys. These results showed that girls had more learning losses due to COVID-19 pandemic. According to the mother's education level; the decrease for mathematics scores were between 9.73 (elementary school degree) and 22.02 points (associate degree). This finding shows that the learning loss in math based on mother educational level is between 15-months and 2.5 years. Similar findings showed up for Turkish scores as well. Turkish scores decreased between 10.43 (elementary school degree) and 22.24 points (associate degree). This finding shows that the learning loss in Turkish based on mother educational level is between 15-months and 2.5 years. These results show that some students did not learn new material after the outbreak and even slipped backwards. Ministry of National Education should take important steps to prevent the effects of COVID-19 pandemic and minimize and resolve the learning losses emphasized in this study.

Keywords: COVID-19, Curriculum Based Assessment, Learning Loss, School Closures, Social Inequality

Introduction

Recent global developments in the educational system have affected nations shockingly. This is directly related to the magnitude of the problem, number of people it affects, possible solutions and implementation timetable. The COVID-19 pandemic is not only a health crisis but also an educational crisis since there were some 1.5 billion kids without proper common schooling (World Bank, 2020) Natural or human-induced events affecting the masses can affect the lives of people and thus their education and training processes (Sarı & Nayır, 2020). Events such as natural disasters, wars, and epidemics may negatively affect the lives of large masses of people, and they can turn into a crisis in which the communities try to survive in a healthy way as soon as possible. An emergency solution must be developed at such times to overcome such crisis in the smoothest way to return to normal life routine.

Educational systems are also affected by mass crisis and learning losses may occur during such crisis depending on the magnitude of the problem. Learning loss can be expressed as the inability to retrieve acquired information from memory (Arı, 2005). Experiencing learning loss means going beyond the determined planning, not gaining or missing the desired competencies, and naturally experiencing problems reaching educational goals (Cooper et al 1996; Slade at al., 2017; Jaume & Willen 2018, Kayır & Özçelik, 2018).

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Learning Losses due to Unplanned School Closures

The literature on school closures due to weather events and natural disasters gives us some insight into the potential impact of COVID -19 school closures, especially given that such closures occur unexpectedly and disrupt scheduled classes (Kuhfeld et al., 2020).Hansen's (2011) study shows that it decreases from 0.013 to 0.039 student days for each day that schools are closed due to snow in Colorado, and the effect of snow days on student achievement in Maryland varies between 0.013 and 0.016 student days. Additionally, Goldman (2014) found that school closures due to snowfall in Massachusetts did not affect mathematics and general reading achievement.

If education is interrupted for one or two days in a school year for unplanned reasons, teachers may make it easier to compensate for the lost time and therefore this may not affect student performance. However, longer periods of absence from school are likely to have greater effects on learning (Kuhfeld et al., 2020). In a recent study, even short-term incidents can cause large learning losses due to school closures. In 2020, Andrabi, Daniels, and Das found that when schools were closed in the region affected by the 2005 Pakistan earthquake for 3 months, there was a difference of 1.5 years, not 3 months, compared to those that were not affected after 4 years.

Research show that school closures occur within a limited time interval of 2 to 5 days during the year due to natural events (Marcotte & Hemelt, 2008). However, due to the COVID-19 pandemic, schools worldwide have been closed since March 2020, and as of the beginning of 2021, they still could not be opened properly. This is well higher than other unplanned school closures. Therefore, considering the other unplanned school closing periods, it is thought that it would be more beneficial to take a look at the studies examining the effect of summer holidays on learning losses, when students stay away from their schools for longer periods.

Summer Vacation Learning Losses

In general, summer learning loss is the event that students lose their academic knowledge and skills due to not going to school during summer holidays. Arı (2005) defined the concept of summer vacation learning loss as not remembering or having difficulty remembering what s/he learned in one school year at the beginning of the next academic year. When the researches are examined, learning losses ranging from 1 to 3 months are estimated and this process is affected according to class level, course subjects and socio-economic conditions (Cooper, 2003; Cooper, Nye, Charlton, Lindsay, & Greathouse, 1996; Entwisle & Alexander, 1992; Alexander et al., 2007). Although these losses are valid for most students, they show that students with low socio-economic status have more pronounced losses in reading (Cooper et al., 1996; Gershenson & Hayes, 2018).

Examining the literature on summer learning loss, we find that learning loss varies by socioeconomic level, parents' relationship status, the student's particular learning status, and the family's educational status. Among these, the most emphasized is the socio-economic level (Entwisle and Alexander, 1992, 1994; Cooper et al., 1996; Downey et al., 2004; Alexander et al., 2007; Slates et al., 2012; Gershenson, 2013; Arı, 2004; Gershenson and Hayes, 2013; Cooper, 2003; Menard & Wilson, 2014).

Specifically, in a meta-analysis study 39 studies examining summer holiday learning losses, revealed three common results regarding summer learning losses. These;

- Learning losses increase as the grade level rises.
- Losses in math skills are greater than learning.
- Learning loss in a summer term corresponds to an average of 1 month of teaching time (Cooper et al., 1996).

The literature on summer learning loss shows that students experience learning loss during summer vacation and that the extent of learning loss can vary depending on the educational level of the family, socioeconomic level, relationship status of the parents, and whether the student has learning difficulties.If education is interrupted for one or two days in a school year due to unplanned school closures, it is easier for teachers to compensate for the lost time and therefore, this may not affect student performance. However, longer periods of being away from school are likely to have greater effects on learning (Kuhfeld et al., 2020). However it is not only having a knowledge gap between what is planned and what is acquired by students, a greater concern is a snowball effect where learning losses become permanent due to the dynamic and spiral nature of curriculum, especially for kids from low-income families.

Determining the extent of learning loss and finding solutions are seen as important for the future of education systems around the world. To measure learning loss, students typically take two of the same standardized tests at different times. The tests used are compared to provide information about where students stand in comparison to peers in the same grade (Baker & Good, 1995). Results from these tests are used to determine how much learning loss might occur between two-time points.

Learning loss is mostly studied due to short-term effects of weather and climate events, natural disasters, strikes, and summer break. Students had no or little access to education in most of these scenarios. Due to nature of COVID-19 pandemic most countries have planned and implemented interventions where students can access education. As of March 16, 2020, Turkey closed all schools nationwide and implemented two different approaches

called EBA TV and eba.gov.tr (EBA stands for Educational Informatics Network), a television broadcast portal and an Internet portal for kids to access education. The reason to create both portals was to give access to the biggest number of students in the K-12 level. Along with that mobile EBA vehicles used to create access points for kids who live in rural areas of the country.

Curriculum Based Assessment (CBA)

Curriculum-based assessment (CBA) is an assessment process that uses academic knowledge picked directly from the material taught in the classroom. This form of criterion-referenced assessment connects evaluation with instructional programs by informing teachers of student progress and learning challenges. A key characteristic of CBA is that it provides a form of direct measurement where teachers assess precisely what they teach, which is not always the case with indirect or norm-referenced assessments that do not necessarily reflect the specific material covered in a particular classroom. Applications of CBA show that results provide stronger findings compared to traditional learning loss detection methods (Deno, Fuchs, Marston, & Shin, 2001; Fuchs, Fuchs, Hamlett, Walz, & Germann, 1993).

Deno and colleagues developed CBM at the University of Minnesota. According to the research team, CBM was designed to measure student progress, which can be used frequently. It also requires less effort to investigate student growth in learning (Deno, 1985, 1992). CBM was widely used in measuring oral reading (i.e., R-CBM; Busch & Reschly, 2007). CBM technique may assess the broad goals of the curriculum. Due to these broad goals compared to criterion-referenced achievement measures a greater overlap between teaching and testing than would be seen (Deno & Fuchs, 1987). Moreover, CBM is capable of multiple applications to produce comparative scores for students from different populations (Allinder, Fuchs, Fuchs, & Hamlett, 1992).

Current Study

The main purpose of this study was to determine the learning losses experienced by Turkish students in Turkish and mathematics lessons during the pandemic period and whether these losses differ according to gender, mother's education level via CBA. The literature mainly focuses on learning losses because of unplanned school closure due to weather or natural disasters and summer vacations. But a record number of children are not going to school because COVID -19 The pandemic has caused the greatest disruption to education systems in history. It is important to provide an overview to those interested in education around the world.The current study was well designed and followed a diverse sample of students from different socio-economic backgrounds, rural and urban areas to optimize results generalizability of the results.

Three main goals of the study were to:
1. To apply Curriculum-based assessment (CBA) to find evidence for possible learning losses,
2. To examine a sample of 8th graders for learning loss due to COVID-19 using raw test results, and
3. To assess the impacts of demographic factors on learning loss, such as gender and the mother's education level.

Method

Participants

The participants of this study were drawn from a mid-size city in Aegean Region of Turkey. Our study consists of 8th grade students who are from urban and rural areas where Internet connectivity and computer access might be limited. Some of the students excluded from analyses were missing a data point either due to not completing the test or marking all the answers but exiting the system in less than 15 minutes. The final sample consisted of 4.501 students from two different data points of 2016 TEOG Exam results and 2020 application of the same exam. Results of the demographic analysis about the sample is shown in Table 1. The total sample consisted of 2.355 girls and 2.180 boys. Another important variable, mother's education level, was differentiated as 3094 moms holding elementary (8 years) education, 969 moms with high school diplomas, 147 moms with associate degrees, and 291 moms with undergraduate degrees.

Table 1. Demographics of the Sample (N = 4.535)

Exam Year	Gender		Mother's Education Level			
	Girl	Boy	Elementary (8 Years)	High School	Associate Degree	Undergraduate
2016	1683	1603	2406	598	93	189
2020	657	558	688	371	54	102
Total	2355	2180	3094	969	147	291

Measure

In Turkey, a centralized standardized exam is used for transition to secondary education. Although there were different versions of transition exams in the past, Transition from Elementary Education to Secondary Education Examination (TEOG) had started from 2013-2014 academic year and ended in 2016-2017 academic year. In TEOG examination, eighth grade students used to take 12 centrally conducted examinations. The common examination subjects were Turkish, Mathematics, Science and Technology, T.R. Revolution History and Kemalism, Foreign Language, Religious Culture and Moral Knowledge. Due to focus of this study only results from Turkish and Mathematics subject areas of 2016 TEOG-1 exam were used. The exam took place on 23-24 November 2016. Although TEOG sounds like a standardized nationwide large scale exam since TEOG Exam is also second or third exam for mentioned subjects for the semester it can also be used as a curriculum based tool. In this study, the same exam from 2016 was adminestered to 8th grade students to determine the possible learning loss on 28 November 2020.

Data Analysis

Data were analyzed in several steps. First, data were screened for assumptions such as outliers and adherence to normality and parametric assumptions. Second, an independent samples t-test was run using test scores to see if there is a significant mean difference between 2016 and 2020. Later, a factorial ANOVA (two-way) analysis was conducted to compare TEOG results from 2016 and 2020 for gender and mother's education level. Analysis used the demographic variables of gender and mother's education level as between-subjects factors and the time of measurement (2016 - 2020) as within-subjects factor.

Studies have shown that demographic variables have strong effect on learning loss. As a result, since gender has strong effect on academic performance it was hypothesized that the variable might have similar effect on learning loss (Sadler-Smith, 1996; Dayioğlu et. al., 2007; Chyung, 2007). This was an important finding of a meta-analysis study conducted by Sirin in 2005. Mother's education level was selected due to being a strong predictor of school performance.

Results and Discussion

Data Screening and Testing for Assumptions
The factorial ANOVA has several assumptions that need to be met:
- interval data of the dependent variable,
- normality,
- homoscedasticity,
- and no multicollinearity.

In this study dependent variable is at the interval level. Data were analyzed to see possible outliers. There were no outliers as a threat to analysis. The distributions of the dependent variables—Math and Turkish scores at each time point—were examined for normality. Z-scores of skewness and kurtosis were less than the absolute value of 1.9, meaning that, there were no significant distributional deviation (Field, 2009). In addition to this, histograms, boxplots, and descriptive statistics were checked. Results showed that the variables' distributions were normal. Means, standard deviations, and ranges for 2016 and 2020 TEOG scores for each group are given in Table 2.

Table 2. Descriptive Statistics for Student Scores (N = 4.535)

Exam Year	Mean (SD)	Skewness	Kurtosis	Range Minimum	Maximum
2016					
Mathematics	57.90 (23.11)	.143	-1.092	5.00	100.00
Turkish	62.97 (19.60)	-.065	-.669	5.00	100.00
2020					
Mathematics	47.58 (22.53)	.143	-.659	0.00	100.00
Turkish	52.06 (21.07)	-.065	-.528	0.00	100.00

Levene's test for equality of error variances was used to test whether the error variances of all data points of the dependent variable were equal or homogeneous across the sample. Levene's test was not significant at the p >.01 level. Moreover, the observations were mutually independent. According to the test results, the assumptions of the analysis were met.

Results of Independent Samples t-test

A t-test was conducted to compare means of both math and Turkish scores of two-time points (Table 3). There was a significant difference between the 2016 and 2020 results, showing that the 2020 students' results were lower than the 2016 results.Table 3. Results of Independent Samples t-test Analysis Examining the Learning Loss Due to COVID-19

	2016 M	SD	2020 M	SD	Mean Difference	t (4533)	p	Cohen's d
Mathematics	57.90	23.11	47.58	22.53	10.32	13.48	.000	0.45
Turkish	62.97	19.60	52.06	21.07	10.91	16.33	.000	0.54

The difference in the scores for math exam 2016 (*M*=57.90, *SD*=23.11) and 2020 (*M*=47.58, *SD*=22.53) conditions; *t* (4533)=13.48, *p* = 0.000. Also the difference in the scores for Turkish exam 2016 (*M*=62.97, *SD*=19.60) and 2020 (*M*=52.06, *SD*=21.07) conditions; *t* (4533)=16.33, *p* = 0.000. The effect size for math exam analysis (*d* = .45) was found to exceed Cohen's (1988) convention for a small effect (*d* = .20) and for Turkish exam analysis (*d* = .54) was found to exceed Cohen's (1988) convention for a medium effect (*d* = .50).

Results of Factorial ANOVA

A Factorial ANOVA was conducted to compare the main effects of gender and year of the test and the interaction effect between gender and year of the test on students` math scores. There was a statistically significant interaction between gender and the year of the exam on students` math scores. F (1, 4497) = 5.520, p = .019.

Table 4. Results of Independent Groups Factorial ANOVA Examining the Learning Loss Due to COVID-19 for Mathematics Exam (Gender vs. Year of Exam)

Source	df	MS	F	p	η^2
Exam Year	1	92392.339	177.238	.000*	.038
Gender	1	4058.746	7.786	.005*	.002
Exam Year x Gender	1	2877.642	5.520	.019*	.001
Error	4497	521.291			

Note.—MS = Mean squares, η2 = effect size, *p < .05
Simple main effects analysis showed that girls had significantly more learning losses in math than boys (p = .002).

Table 5. Means for Learning Loss Due to COVID-19 for Mathematics Exam (Gender vs. Year of Exam)

Mathematics	2016 M	SD	2020 M	SD	Mean Difference
Girl	59.72	22.91	47.68	21.66	12.04
Boy	55.77	23.04	47.34	23.28	8.43

Another Factorial ANOVA was conducted to compare the main effects of gender and year of the test and the interaction effect between gender and year of the test on students` Turkish scores. There was no statistically significant interaction between the effects of gender and year of the exam on students` Turkish scores *F* (1, 4497) = 3.279, *p* = .070.

Table 6. Results of Independent Groups Factorial ANOVA Examining the Learning Loss Due to COVID-19 for Turkish Exam (Gender vs. Year of Exam)

Source	*df*	MS	F	*p*	η^2
Exam Year	1	105668.357	272.635	.000*	.057
Gender	1	30843.311	79.579	.000*	.017
Exam Year x Gender	1	1254.689	3.237	.072	
Error	4497	387.582			

Note.—MS = Mean squares, η2 = effect size, *p < .05

A third Factorial ANOVA was conducted to compare the main effects of mother's education level and year of the test and the interaction effect between mother's education level and the year of the test on students` math scores. There was a statistically significant interaction between the effects of mother's education level and the year of the exam on students` math scores. $F (1, 4493) = 9.057$, $p = .000$.

Table 7. Results of Independent Groups Factorial ANOVA Examining the Learning Loss Due to COVID-19 for Mathematics Exam (Mother's Education Level vs. Year of Exam)

Source	*df*	MS	F	*p*	η^2
Exam Year	1	82888.812	181.315	.000*	.039
Gender	3	73060.954	159.817	.000*	.096
Exam Year x MomsEducation	3	4140.524	9.057	.000*	.006
Error	4493	457.153			

Note.—MS = Mean squares, η2 = effect size, *p < .05

Simple main effects analysis showed that kids whose mothers eld an associate degree had more learning losses in math than the rest (MD= 22.02) (see Table 8).

Table 8. Means for Learning Loss Due to COVID-19 for Mathematics Exam (Mother's Education Level vs. Year of Exam)

Mathematics	2016		2020		
	M	SD	M	SD	Mean Difference
Elementary (8 Years)	53.10	21.66	43.37	21.19	9.73
High School	65.49	21.55	48.63	21.52	16.86
Associate Degree	78.87	18.53	56.85	22.51	22.02
Undergraduate	82.86	17.94	66.72	21.95	16.14

A fourth Factorial ANOVA was conducted to compare the main effects of mother's education level and year of the test and the interaction effect between mother's education level and year of the test on students` Turkish scores. There was a statistically significant interaction between the effects of mother's education level and year of the exam on students` Turkish scores. F (1, 4493) = 7.645, p = .024.

Table 9. Results of Independent Groups Factorial ANOVA Examining the Learning Loss Due to COVID-19 for Turkish Exam (Mother's Education Level vs. Year of Exam)

Source	df	MS	F	*p*	η^2
Exam Year	1	79652.570	222.654	.000*	.047
Gender	3	44034.638	123.091	.000*	.076
Exam Year x MomsEducation	3	2734.767	7.645	.000*	.005
Error	4493	357.741			

Note.—MS = Mean squares, η2 = effect size, *p < .05

Simple main effects analysis showed that kids whose mothers eld an associate degree had more learning losses in math than the rest (MD= 22.24) (see Table 10).

Table 10. Means for Learning Loss Due to COVID-19 for Turkish Exam (Mother's Education Level vs. Year of Exam)

Turkish	2016		2020		
	M	*SD*	*M*	*SD*	Mean Difference
Elementary (8 Years)	59.26	18.70	48.83	20.48	10.43
High School	68.48	18.52	52.89	19.02	15.59
Associate Degree	81.12	12.94	58.88	20.36	22.24
Undergraduate	82.14	15.61	66.91	23.49	15.23

Conclusion

When the pandemic COVID -19 led to school closures, many of us had no idea that this disruption would last months and perhaps more than a year. However, when this study was conducted, access to personal education in Turkey had not been provided in a healthy and usual manner for about 10 months, including the summer vacations. However, education in Turkey is a pathway for transition between social classes. Especially the children of families living in lower socio-economic strata use education to change their social class. At this point, access to education is critical for the children of disadvantaged families.

In this study, following analysis were done by using the Turkish and Mathematics data of the 2016 TEOG exam to reveal a possible learning loss:

1.   Examine a sample of 8th graders for learning loss due to COVID-19 using raw test results, and
2.   assess the sample if there is evidence of learning loss based on demographic factors, such as gender, mother's education level.

When COVID -19 began to spread rapidly in the spring, our educational system was quite lacking in the equipment and infrastructure to respond to it. The Turkish National Education System, or more accurately its ecosystem has been built around a school and classroom-based experience. In many homes, especially for socio-economically disadvantaged families, students have limited access to the internet, devices, and even a quiet place reserved to study.

For this reason, inequalities in learning conditions were directly reflected in the results obtained in this study.

Research Q1

The data showed that there was a one and a half year learning loss in both Turkish and mathematics based on Woesmann (2016)`s findings. According to Woesmann (2016), in national and international standardized large-scale exams, one-year learning corresponds to a value between one-fourth and one-third of the standard deviation of the exam. The difference in the scores for math exam between 2016 and 2020 was 10.32 points which accounts for half of exam standard deviation. Also, the difference in Turkish exam 2016 and 2020 was 10.91 points which is also around half of the standard deviation. This may seem reasonable in a storm that is caught unprepared, but learning losses increase up to two or three years of education in disadvantaged groups, which was subgrouped based on mother`s education level, is an important finding.

Research Q2

In this study, gender and mother`s educational level to compare learning losses based on demographic factors. Based on gender there was a statistically significant decrease of 12.04 points in the mathematics scores of girls and 8.43 points for boys showing a 15-month learning loss for girls. and a year of learning loss for boys. These results indicated that girls had more learning losses due to the COVID-19 pandemic.

According to the mother's education level; the decrease for mathematics scores were between 9.73 (elementary school degree) and 22.02 points (associate degree). This finding shows that the learning loss in math based on mother educational level is between 15-months and 2.5 years. Similar findings showed up for Turkish scores as well. Turkish scores decreased between 10.43 (elementary school degree) and 22.24 points (associate degree). This finding shows that the learning loss in Turkish based on mother educational level is between 15-months and 2.5 years.

Research emphasize that family`s educational status helps children to have less learning losses (Entwisle and Alexander, 1992, 1994; Cooper et al., 1996; Downey et al., 2004; Alexander et al., 2007; Slates et al., 2012; Gershenson, 2013; Arı, 2004; Gershenson and Hayes, 2013; Cooper, 2003; Menard & Wilson, 2014). However findings of this study show that kids with mothers holding higher educational degrees have more learning losses. COVID-19 pandemic closures affected schools most but businesses and factories mainly were open in Turkey. Ministry of National Education`s efforts to minimize the effects of the pandemic was mostly based on TV programs through EBA TV. Since mothers with higher educational degree were at work during these times and mothers with lower educational degrees were at home kids with more educated mothers had more learning losses. Specifically, mothers holding associate degrees were hired at factories in Usak meaning that their kids have the higher learning losses.

However, these results are only a snapshot of a small section of the students. Considering the social, demographic and cultural structure of Usak, it can be regarded as that these students perform better than the national averages.

Recommendations

These assessments were obtained by administering the 2016 TEOG exam to students with internet access online in 2020 on similar dates. These results show that some students did not learn new material after the outbreak and

even slipped backwards. Ministry of National Education should take the following steps to prevent effects of COVID-19 pandemic as well as minimize and resolve the learning losses emphasized in this study.

- Schools should be maintained in a way to provide face-to-face education. This is because the problems experienced in accessing the internet, software and hardware are at the root of the learning losses experienced.
- To compensate for the pandemic learning loss, comprehensive, accessible and effective strategies should be developed to cover cognitive, affective and social learning losses.

Acknowledgements or Notes

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