

Tracing Science and Mathematics Learning Loss for the Sixth and Ninth Graders Compared with Students' Hypothetical Average Scores during Covid 19 pandemic

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Abstract

The study aimed to gauge the extent of learning loss in mathematics and science among the sixth and ninth graders in Bani Obaid directorate of education due to the pandemic disruption. The descriptive analytical approach was used to analyze the study sample results on previously prepared tests and comparing them with the hypothetical average scores of students' results during the last three years. Two science and two mathematics tests were used and applied to a random sample of 128 male and female students in two government schools. The results indicated that there is a learning loss among the study sample in science and mathematics during Covid-19 compared with the hypothetical average scores of students in the last three years, in addition, learning loss estimates were larger for mathematics than for science. Based on the findings, the researcher recommended developing a clear system addressing learning losses and gaps, bearing in mind that the loss can be different from one student to another and the mechanism triggered may not suit all of them. Further studies were suggested to identify learning losses at other levels and academic courses.

Kew words: Learning loss; science and mathematics; Covid-19 pandemic; Bani Obaid directorate of education.

1. Introduction

The Covid-19 pandemic has triggered a universal disruption over the past two years, and caused unforeseen and formidable changes. Since its outbreak in late 2019, it has created unprecedented havoc in all areas and escalated into a global pandemic. Like any vital sector, the educational system in all its areas of action has been severely affected, numerous countries around the world decided to close schools nationwide to prevent or contain the spread of the virus, resulting in a sudden, global shift to distance education that has soared in response to the coronavirus crisis. As a result, students were deprived of their opportunities of face-to-face interaction and learning the necessary skills such as how to learn, listen and collaborate. This resulted in extended gaps between what they

actually gained and what is planned according to the intended curriculum, framed by so-called learning-loss.

The issue of learning loss received great global attention before the Covid-19 pandemic, and the matter became more complicated after the pandemic. Students around the world have lost substantial instructional time owing to suspension of face-to-face instruction in schools and the shift to distance education, which has led to concerns about consequences for students' learning. Experts believe that learning loss was most pronounced among students, remote classes would never be an adequate substitute for in-person learning, and there are many vital and effective attributes that distance learning simply cannot accommodate. Educational research centers tended to research the measures that can

be taken to help students recover from learning losses.

Learning loss term is not related to Covid-19 pandemic; educational literature reports definitions of learning loss before the pandemic, it has been defined by (the Great School Partnership, 2013) website, as “any specific or general loss of knowledge and skills or reversals in academic progress, most commonly due to extended gaps or discontinuities in a student’s education”.

The concept of learning loss includes four types: (1) The complete loss of knowledge; (2) Naïve knowledge: students acquire simple knowledge and interpret it in a way that contradict the scientific explanation; (3) Inert knowledge: the abstract memorization of scientific concept, students acquire an idea without learning the conditions of its subsequent application; (4) Ritual knowledge which is useful in academic subjects but falls short when needed to apply the knowledge in practical and non-traditional situations (Perkins, 1992).

The causes of learning loss varied during the Corona pandemic, school closures have increased inequality in students’ access to learning opportunities, their role as an equalizer for educational opportunities was reduced during the pandemic and the teaching methods used were inappropriate for all students. Moreover, learners from disadvantaged homes could not access all or most of the educational opportunities during school closures across the world, along with several factors such reasons related to busy families who are not following up on their children, students’ learning styles, characteristics, motivation, feeling of loneliness and lack of interaction. Loeb (2020) indicated that the study via the Internet in general is not as effective as in-person study.

The world bank group education (2020) reported simulations estimating the potential impacts of the COVID-19 pandemic in learning poverty. 382 million primary school age children are learning poor, either out of school or below the minimum proficiency level in reading. COVID-19 could boost that number by an additional 72 million to 454 million. Simulations show

learning poverty increasing from 53 percent of primary-school-age children to 63 percent and this is necessarily accompanied by a high percentage of learning loss among students.

Organizations and specialized centers have been interested in estimating the learning loss and the World Bank (2020a) expects three scenarios for it: namely (1) all children lose the same amount of learning; (2) the most disadvantaged students lose the most; those who were already fall further behind while those at the top are unaffected, inequality worsens; (3) the worst, performance of all students significantly declines when they do not return to school to work with their parents (especially in poor countries) or because of weak education budgets in some countries and their inability to provide teachers and forced to integrate schools to reduce costs.

According to (Azevedo, et al. 2022) there are two possible scenarios for compensating the learning losses: The optimistic scenario is that there is a loss of 60% and 40% of it can be compensated for in high-income countries and 30% in low-income countries. The pessimistic scenario assumed that there is no remedy for the loss, and only 10% of the losses can be compensated for in high-income countries and only 7% in the developing countries.

All countries of the world are keen to ensure qualitative learning for all students and working to provide equal learning opportunities for them. Therefore, the ministries of education have been dealing seriously to compensate students' learning loss and taking interest in technology-based teaching designs.

school closures and the transition to distance and hybrid learning is sounding the alarm about the potential risk of learning losses at the local and global level which have resulted in significant effects on students' acquisitions and cognitive competencies, in addition to psychological, social and health impact (Tremmel et al., 2020) 1.31 million students are at risk of dropping out of school due to the Covid-19 crisis, indicating that these students may not return to their educational institutions (UNESCO, 2020).

A report issued by UNICEF indicated that approximately 40% of students in the Middle

East and North Africa did not benefit from any distance education initiative, and most of them were from vulnerable and disadvantaged groups UNICEF (2020).

At the local level, the economic and social council of Jordan (ESC) confirmed that some teachers who are on the verge of retirement suffer from the lack of knowledge, skills and proper electronic devices to deal with distance education. The educational leaders took the decision to deal with this new experience and came out with minimal losses. conversely, they admitted that they have made progress but not as much as they would like due to teachers' strikes, the epidemiological situation, and the continuation of distance learning (ESC, 2020).

Learning loss during the pandemic has been the focus of several studies. Iqbal et al. (2020) using data on 157 countries, reported that the global level of schooling and learning will fall, COVID-19 could result in a loss of between 0.3 and 0.9 years of schooling adjusted for quality, bringing down the effective years of basic schooling that students achieve during their lifetime. Also, Azevedo et al. (2020) estimated through simulating the potential impacts of the COVID-19 school closure for five months that there could be a loss of 0.6 school years, while school closures could lead to 25% increase in the share of lower secondary-aged children who are below the minimum level of proficiency and an increase in learning poverty, particularly in the poorest countries.

UNESCO institute for statistics and the upcoming world bank report define learning poverty as being unable to read and understand a simple text by age ten. This definition brings together schooling and learning indicators: it begins with the share of children who have not achieved minimum reading proficiency (as measured in schools) and is adjusted by the proportion of children who are out of school (and are assumed not able to read proficiently (World Bank, 2019a, p. 6; World Bank, 2019b). This concept allows finding a difference between teaching and learning, since it is not necessary that everyone who comes to school will learn (Pritchett, 2013).

Niemi & Kousa, (2020) identified the assessment of both students and teachers about distance education during the COVID-19 pandemic in one local upper secondary school in Finland. The study sample varied from 56 to 72 students and 9 to 15 teachers at different times. The data were analyzed by descriptive statistics. The main findings indicated that distance teaching was implemented very successfully. Conversely, open comments revealed many challenges, students complained of heavy workloads, fatigue and losing motivation. The main challenges for teachers included non-authentic interaction and a lack of the spontaneity that in-person teaching provides. The study also revealed teachers' concern about students' progress and teachers' lack of awareness of the heavy workloads placed on them.

Al-Haib (2021) evaluated the experience of distance education in light of the Corona pandemic from the school principals, teachers and students' viewpoint in the Arab Sector in Palestine. To achieve the objectives of the study, the descriptive method was adopted and a questionnaire instrument was used to collect data. The study sample consisted of (90) principals, (320) teachers and (169) male and female students. The study revealed that students' benefit from distance education was medium.

Ahmed (2020) investigated the reality of applying distance learning in secondary schools in light of the Corona pandemic in Al-sharqia Governorate from the students and teachers' viewpoint and the obstacles that hinder employing it. The descriptive analytical method was used, the sample of the study was randomly selected and consisted of 130 teachers and 250 male and female students from general secondary education. The findings revealed some barriers to distance learning, which can hamper or completely prevent the utilization of distance learning such as the lack of direct communication between teachers and learners, ignoring social and recreational activities, little catering for individual differences and the high internet subscription fees.

Hevia, et al. (2020) carried out a study to estimate learning loss in reading and numeracy in Mexico, comparing the results of two household

surveys conducted in 2019 and 2021. 3161 children were interviewed between 10 and 15 years. Socio-economic status estimated a learning loss in a range from 0.34–0.45 SD in reading and 0.62–0.82 SD in mathematics by COVID-19 pandemic, and an increase in learning poverty in a range of 15.4% - 25.7% in reading and 28.8% - 29.8% in numeracy. In addition, gaps in fundamental learning by gender increased.

Azevedo, et al. (2022) presented simulations of the potential effect of COVID-19-related school closures on schooling and learning outcomes. The descriptive analytical method was used to analyze data of 174 countries. Four scenarios were considered varying in both the duration of school closures and the effectiveness of any mitigation strategies being deployed by governments. The findings indicated that the global level of schooling and learning would fall substantially. School closures could result in a loss of between 0.3 and 1.1 years of schooling, bringing down the effective years of basic schooling that students achieve during their lifetime. Exclusion and inequality will likely be exacerbated of marginalized and at-risk groups, such as girls, ethnic minorities, and persons with disabilities. Globally, a school shutdown of five months could generate learning losses that have a present value of 10 trillion dollars. By this measure, the world could stand to lose as much as 16 percent of the investments that governments make in the basic education. In the very pessimistic scenarios, cumulative losses could add up to between 16 and 20 trillion dollars in present value terms. Unless drastic remedial action is taken, the world could face a substantial setback in achieving the goal of halving the percentage of learning poverty by 2030.

Story and Zhang (2021) conducted a study to generate a comprehensive and up-to-date review concerning the impact of the coronavirus pandemic on K-12 student achievement in the U.S. and similar countries, seeking to add a deeper understanding of the precise effect of COVID-19 on learning across subgroups and identifying student learning loss by subject, class, and country. The findings might provide meaningful and practical information for decision

makers to develop appropriate learning loss remediation policies and programs. The study used the quantitative approach to measure students' achievement prior and during the pandemic through meta-analysis of ten studies that aimed to measure learning loss resulting from the pandemic and excluded studies that measured learning loss caused by other reasons than the pandemic. The results showed that students lose 15 % of learning during the pandemic school closures. It also indicated that students' math achievement is somewhat more negatively affected compared to reading achievement, and that students of higher grades lost less learning compared to lower grades students.

Engzell et al. (2021) evaluated the effect of school closures on primary school performance using rich data of 350000 students from The Netherlands, relying on the fact that national examinations took place before and after lockdown and compare progress during this period to the same period in the last three years. The results revealed a learning loss of about 3 % (0.08 SD). The effect is equivalent to one-fifth of a school year, the same period that schools remained closed (eight weeks). In addition, losses are up to 60% larger among students from less-educated homes, where they have made little or no progress. Moreover, most of the effect reflects the cumulative impact of knowledge learned rather than transitory influences on the day of testing; confirming worries about the uneven charge of the pandemic on children and families. Results suggest losses even larger in countries with weaker infrastructure or longer school closures.

Canovan and Fallon (2020) investigated the effects of UK's Covid-19-related school closures on primary science teaching and learning from the teachers and students' perspectives. The researchers used an interview and a questionnaire to collect data of (77) parents and (33) teachers during the closures of spring 2020 and early 2021. The results revealed that science teaching had entrenched inequality among learners; in addition, little progress had been made in mitigating science-learning loss at primary level, with less than 10% of parents aware of any

efforts in this regard. Meanwhile, a number of teachers were worried that reversing science learning loss was not a priority for schools. Parents felt that home learning in the second closure period was much more effective than in 2020, however, it was still perceived by many to be disappointing in quantity and quality. On the other hand, teachers believe that the access to IT had largely been addressed. The results also showed that a lack of catch-up activity threaten science learning loss being forgotten, while the second round of lockdown has likely exacerbated the relative learning loss in science over other core' subjects.

Al-Anazi (2021) sought the suggestions of teachers and educational supervisors to address the learning loss in the Kingdom of Saudi Arabia. For that purpose, the study used the qualitative research method based on the case study approach. The instrument was a one question-structured interview asked to 17 male and female teachers and educational supervisors from various specializations and educational levels, chosen through purposeful and snowball sampling methods. Upon analyzing the data objectively, the results showed that addressing the learning loss could be achieved through six strategies: using supportive teaching programs and mechanisms, applying flexible study schedule, improving teachers and students' performance, implementing evaluation in scientific ways, applying technology in the teaching process and the cooperation of educational authorities inside and outside the school.

A good body of research was reviewed, which is similar to the current study in terms of objectives (e.g. Hevia, et al.2020; Azevedo, et al.2022; Engzell et al. 2021) , methodology (e.g., (Hevia, et al.2020; story & Zhang 2021) and findings (e.g., Azevedo, et al.2022; Hevia, et al.2020; story & Zhang 2021; Engzell et al. 2021). The current study is distinguished by the fact that it attempted to estimate learning losses in two basic fields (mathematics and science) in government schools in Bani Ubaid District; while the previous studies aimed to estimate the learning loss in general or through simulation.

Learning losses are expected due to COVID-19 related school closures, the ad hoc implementation of online teaching gave students, teachers, schools, and parents little time to prepare for or adapt to measures of remote learning that proofed to be inadequate for all students who differ in abilities, learning styles and intelligence. Consequently, there is an urgent need to estimate students' learning loss in science and mathematics as they are basic subjects and learned cumulatively.

Jordan announced a state of emergency since mid-March 2020. The government closed all borders and implemented a national lockdown in response to COVID-19. All schools and educational establishments suspended classes and moved to online education in which hybrid teaching has returned since the beginning of the 2021/2022 school year.

1.1 Problem of the study

Based on educational literature, the results of learning loss is still matter of controversy. Research (see, for example, story & Zhang 2021) showed that students lose 15 % of learning during the pandemic school closures, while (Engzell et al. 2021) revealed a learning loss of about 3 % (0.08 SD) which is equivalent to one-fifth of a school year, and (Canovan; Fallon, 2020) indicated that school closures have likely exacerbated the relative learning loss in science over other core' subjects.

UNESCO, UNICEF and the World Bank (2021) indicated that there is no systematic evidence available to date on how student learning has been affected by the pandemic or about the impact of the educational response launched by governments, their report included a series of simulations of potential learning loss caused by the pandemic and its long-term effects.

The results of distance learning are also matter of controversy. Studies (e.g., Niemi, & Kousa, 2020) revealed many challenges for teachers included non-authentic interaction, lack of the spontaneity and their concern about students' progress. In addition, Muhammed & kainat (2020) assured that distance education could not

achieve the desired results in some countries or regions; where Lack of connectivity and devices excluded the vast majority of students from pursuing learning remotely as well as a lack of face-to-face interaction especially in higher education, which may result in a learning loss for students.

There is big ambiguity about the amount of learning loss and the absence of its accurate assessment in school subjects at different levels. Since science and mathematics are of a hierarchical nature in curriculum, they have prerequisite requirements, which must be met before teaching new competencies. Based on the foregoing, the researcher believes that there is an urgent need to estimate the amount of learning loss in science and mathematics for the sixth and ninth graders in Bani Obaid directorate of education. Therefore, the study seeks to answer following questions:

- 1- Are there statistically significant differences at ($\alpha \leq 0.05$) in the sixth-graders' achievement in science due to the COVID-19 pandemic?
- 2- Are there statistically significant differences at ($\alpha \leq 0.05$) in the sixth-graders' achievement in mathematics due to the COVID-19 pandemic?
- 3- Are there statistically significant differences at ($\alpha \leq 0.05$) in the ninth-graders' achievement in science due to the COVID-19 pandemic?
- 4- Are there statistically significant differences at ($\alpha \leq 0.05$) in the ninth-graders' achievement in mathematics due to the COVID-19 pandemic?
- 5- Are there statistically significant differences at ($\alpha \leq 0.05$) in learning loss during the Covid-19 pandemic according to the educational subject (science, mathematics)?

1.2 Study objectives

The current study seeks to achieve the following research objectives:

- 1- Measuring learning loss in science for the sixth and ninth grades in Bani Obaid directorate of education.

- 2- Measuring learning loss in mathematics for the sixth and ninth grades in Bani Obaid directorate of education.

- 3- Comparing learning losses between science and mathematics.

1.3 Significance of the study

The findings of the study are expected to provide potentially significant information in the following aspects:

- 1- Shedding new light on the issue of learning loss that concerns policy makers and ministries of education around the world.
- 2- Providing a fertile field for research concerned with learning loss in various academic courses.
- 3- Providing practical guidance to those involved in the educational process and learning loss to turn challenges and obstacles into opportunities.
- 4- Measuring learning losses amongst the sixth and ninth graders in science and mathematics in the first semester.
- 5- Providing a diagnostic test that can be used to identify the amount of learning loss in science for the sixth and ninth grades.

The researcher benefited from previous studies in presenting and enriching the theoretical literature, developing the study instrument, determining the methodology used and discussing the results. To the best of the researcher's knowledge, the current study is the first of its kind to measure the amount of learning loss in science and mathematics, as the researcher could not locate any local or Arab study in the same regard, which prompted the researcher to conduct it. Therefore, the study will contribute positively to further endeavors to theoretical research and practical development work of learning.

1.4 Limitations of the study

The generalizability of the findings may be limited to the extent to which the study sample represents their counterparts in Bani Obaid

Directorate of Education. It is also limited to science and mathematics textbooks, 2020th edition 2019th edition respectively, for the sixth and ninth grades of the first semester. Therefore, these two limitations lead well to future research.

1.5 Terms of definitions

- **Learning loss:** any specific or general loss of knowledge and skills or reversals in academic progress, during the specified learning time within specific courses. In the study, it is calculating the averages means of the students' responses to the tests that were prepared.
- **Coronavirus:** is an infectious disease called COVID-19 emerged in December 2019 and has caused respiratory illness. The disease has since spread worldwide, leading to an ongoing pandemic (World Health Organization, 2020).
- **Science:** It is one of the basic textbooks taught as a compulsory subject for all students at all levels of study.
- **Mathematics:** It is one of the basic textbooks taught as a compulsory subject for all students at all levels of study.
- **Hypothetical mean:** represents the mean of the study sample results in mathematics and

science for the previous academic years 2016/2017, 2017/2018 and 2018/2019.

- **Bani Obaid Directorate of Education:** is located in Irbid city in the north of Jordan and includes 715 public schools, and 3305 teachers. (Ministry of Education, 2020)

2. Method

The descriptive analytical method was used to estimate the learning loss in mathematics and science for the sixth and ninth grades.

2.1 Study sample and population

The study population consisted of all students of the sixth and ninth grades for the academic year (2021-2022) in two schools in the same area and close to each other: Al-Sareeh Basic for males and Al-Sareeh Basic for females. Thus, it can be said that the study population consists of economically and socially homogeneous environment.

The study sample consisted of male and female students who were drawn from the study population by stratified random sampling method ($n = 128$) and distributed into four classes as shown in Table 1 below:

Table 1: Distribution of study sample members according to school, gender and grade

School	Gender	Grade	No	%
Al-Sareeh Basic for males and	Male	Sixth	31	0.24
		Ninth	29	0.23
Male total			60	0.47
Al-Sareeh Basic for	Female	Sixth	33	0.26

females		
	Ninth	
	35	0.27
Female total	68	0.53
Total	128	%100

Table 1 elucidates 128 male (46%)and female (53%) students in two government schools from Bani Obaid Directorate of Education distributed randomly among four classes, two for each school.

2.2 Psychometric properties of the sixth grade science and mathematics tests.

Validity of the study instrument

Content validity

The researcher analyzed the tests in terms of concepts, facts, rules and laws to make sure that they cover all relevant parts of the subject they aim to measure and then the relative weights of subjects were determined based on the study objectives. In the end, a table of specifications was prepared and test items were developed.

Face validity

In order to examine the apparent validity of the instruments, a panel of educational experts reviewed the instrument (science and mathematics teachers, supervisors at the ministry of education and measurement and evaluation specialists). The team validated the content of the instruments concerning its items, appropriateness

to the purposes of the current study, the language clarity, and how well they represent tracing the learning loss in mathematics and science for the sixth grade. The teams' comments and recommendations were studied carefully and taken into account in amending the final version of the instrument.

Construct validity by internal consistency of items

To check the construct validity of the instrument, the two tests were applied to a pilot group of 29 students selected randomly and left out later from the study sample. The test reliability coefficient was estimated using the internal consistency method by calculating the correlation coefficients between each dimension and the total score of the test. All correlation coefficients were found high and significant at ($\alpha \leq 0.05$) which considered suitable to conduct the study.

Discriminant validity

The discriminant validity coefficient between the upper and lower groups in science and mathematics tests was calculated. Table 2 shows the mean, standard deviation, and T value of two independent samples.

Table 2: the differences between the upper and lower groups in science and mathematics tests for the sixth grade

Test	Group	No	Mean	SD	T value	DF	DF
Science	Upper	10	30.20	4.185	-11.979	18	.000
	Lower	10	12.20	2.251			
Mathematics	Upper	10	30.70	1.829	-16.721	18	.000
	Lower	10	11.70	3.093			

Table 2 shows that T value in the second educational circle equals 11.979 and 16.721 in science and mathematics tests respectively, which is statistically significance. Accordingly, the two tests have an acceptable degree of discriminant validity and applicability.

Reliability of the study instrument

The reliability coefficient was calculated in two ways:

- Dividing the tests into two parts using a split-half coefficient, then the Spearman-Brown

Coefficient was calculated between the students' scores on the even-numbered items and the odd-numbered items.

- Calculating the reliability of the internal consistency, using Cronbach's alpha. the values of reliability coefficients for science and mathematics tests of the sixth grade were calculated as show it table 3 below:

Table 3: Reliability coefficients for the science and math for the sixth grade

Test	Reliability coefficient	
	reliability of the internal consistency using Cronbach's alpha	Spearman-Brown Coefficient
Science	.841*	.785*
Mathematics	.863*	.812*

*Statistically significant at ($\alpha = 0.05$)

Table 3 indicates that the two tests have a high reliability and internal consistency and considered relevant to conduct the study.

Statistical analysis of science and mathematics tests items for the sixth grade

Item difficulty and item discrimination for science and math tests were calculated. The values of the difficulty for sixth grade science test items ranged between (0.24-0.83) and a mean of 0.54. The values of the discrimination ranged between (0.15- 0.72) and a mean of 0.41. Also, the values of the difficulty for sixth grade math test items ranged between (0.17-0.86) and a mean of 0.55. The values of the discrimination ranged between (0.201-0.723) and a mean of 0.41. which all remained within the acceptable limits.

2.3 Psychometric properties of the ninth grade science and mathematics tests.

Content validity

The researcher analyzed the tests in terms of concepts, facts, rules and laws to make sure that they cover all relevant parts of the subject they aim to measure and then the relative weights of subjects were determined based on the study objectives. In the end, a table of specifications was prepared and test items were developed.

Face validity

In order to examine the apparent validity of the instruments, a panel of educational experts reviewed the instrument (science and mathematics teachers, supervisors at the ministry of education and measurement and evaluation specialists). The team validated the content of the

instruments concerning its items, appropriateness to the purposes of the current study, the language clarity, and how well they represent tracing the learning loss in mathematics and science for the ninth grade. The teams' comments and recommendations were studied carefully and taken into account in amending the final version of the instrument.

Construct validity by internal consistency of items

To check the construct validity of the instrument, the two tests were applied to a pilot group of 34 students selected randomly and left out later from the study sample. The test reliability coefficient was estimated using the internal consistency method by calculating the correlation coefficients between each dimension and the total score of the test. All correlation coefficients were found high and significant at ($\alpha \leq 0.05$) which considered suitable to conduct the study.

Discriminant validity

The discriminant validity coefficient between the upper and lower groups in science and mathematics tests was calculated. Table 4 shows the mean, standard deviation, and T value of two independent samples.

Table 4: the differences between the upper and lower groups in science and mathematics tests for the ninth grade:

Test	Group	No	Mean	SD	T value	DF	DF
Science	Upper	12	30.92	3.315	-10.885	22	.000
	Lower	12	13.50	4.442			
Mathematics	Upper	12	33.00	2.954	-18.381	22	.000
	Lower	12	14.42	1.881			

Table 2 shows that T value in the second educational circle equals 10.885 and 18.381 in science and mathematics tests respectively, which is statistically significance. Accordingly, the two tests have an acceptable degree of discriminant validity and applicability.

Reliability of the study instrument

The reliability coefficient was calculated in two ways:

- Dividing the tests into two parts using a split-half coefficient, then the Spearman-Brown

Coefficient was calculated between the students' scores on the even-numbered items and their scores on the odd-numbered items.

- Calculating the reliability of the internal consistency, using Cronbach's alpha. the values of reliability coefficients for science and mathematics tests of the sixth grade were calculated as show it table 5 below:

Table 5: Reliability coefficients for the science and math for the ninth grade:

Test	Reliability coefficient	
	reliability of the internal consistency using Cronbach's alpha	Spearman-Brown Coefficient
Science	.858*	.832*
Mathematics	.857*	.867*

*Statistically significant at ($\alpha = 0.05$)

Table 3 indicates that the two tests have high reliability and internal consistency and considered relevant to conduct the study.

Statistical analysis of science and mathematics tests items for the ninth grade

Item difficulty and item discrimination for science and math tests were calculated. The values of the difficulty for ninth grade science test items ranged between (0.26-0.86) and a mean of 0.58. The values of the discrimination ranged between (0.15- 0.70) and a mean of 0.39. Also, the values of the difficulty for ninth grade math test items ranged between (0.31-0.80) and a mean of 0.59. The values of the discrimination ranged between (0.203-0.692) and a mean of 0.39, which all considered within the acceptable limits as shown in.

2.4 Study instruments

This study aimed at tracing learning loss in science and mathematics for the sixth and ninth grades, and to answer the study questions, the researcher built the following study instruments:

- 1- **Diagnostic tests:** the tests aimed at estimating the amount of learning loss among students in science and mathematics for the sixth and ninth grades resulted in the Covid 19 pandemic and the closure of educational institutions. It is important for young learners to establish a solid foundation in math and science that opens doors to financial literacy, critical thinking and healthy decision-making, therefore, it is essential that schools address these two subjects in early learning.

2- **Unit analysis:** The content in the first semester of science and mathematics for the sixth and ninth grades was analyzed, in addition to building a table of specifications for each test.

3- Writing a set of paragraphs that take into account the cognitive levels specified in the table of specification for each test. Test items in its final form consisted of 40 multiple-choice paragraph of four alternatives each, the questions allow only one answer to be chosen.

4- Converting the diagnostic test into an electronic format through the Google Form program.

2.5 Study procedures

The following procedures were carried out to answer the questions of the study

1- Two schools were purposefully selected in Bani Obaid Directorate of Education: Al-Sareeh Basic for males, and Al-Sareeh Basic for females.

2- Identifying the study sample from the sixth and ninth grades with two classes in each school that were randomly chosen.

3- The tests were applied to the study sample in the first semester 2020-2021 through an electronic link, and the students' answers were electronically corrected.

2.6 Study variables

The research included the following variables:

- 1- learning loss in science and mathematics for the sixth and ninth grades.
- 2- Gender (male and female).
- 3- Education stages (primary and middle).

2.7 Statistical treatment

To determine the amount of learning loss in science and mathematics for the sixth and ninth graders, T-test for one sample was used to determine whether there are statistically significant differences at ($\alpha \leq 0.05$) in students' achievement attributed to COVID-19 pandemic.

3. Results and discussion

The first research question sought if there are statistically significant differences at ($\alpha \leq 0.05$) in the sixth-graders' achievement in science due to the COVID-19 pandemic.

T-test for single-sample analysis revealed that the hypothetical mean value was 33.72, which was compared to the mean of the sixth grade students' results in the schools in science for the previous three academic years 2016/2017, 2017/2018 and 2018/ 2019 as shown in Table 6 below:

Table 6: A one-sample T-test indicating the difference between the study sample mean and the hypothetical mean of the sixth-grade students in science

		Hypothetical mean							33.72
Axis	No of study sample	Mean	Difference in means	SD	df	T-value	Siq	Result	
Sixth grade students' achievement in science	73	29.00	-4.720	4.784	72	-8.429	.000	Significant	

Table 6 indicates that the mean of the study sample members was 29 (SD 4.784) which is less than the hypothetical mean (33.72) for the sixth grade students by (4.72). The differences were statistically significant at $\alpha \leq 0.05$, which showed that there is learning loss in students' competencies in science due to the Covid-19 pandemic.

The result can be explained by students' absence during distance learning. Increased absenteeism has been a by-product of remote learning and the reasons of absenteeism before the pandemic have been replaced with new ones. Missing the school bus has been replaced with having poor internet connectivity or confusion about how to access online classes. In addition, some students turn on the class link and busy themselves with other things such as sleeping or playing. In addition, parents are taking on much more responsibility for their kids' learning than ever before. However, they are not trained to do so and unable to follow them (Hebebcı et al., 2020).

The result can also be attributed to several reasons such as: reduced learning time during COVID-19 and school closures for a period of time (OECD, 2011) and that distance learning is not an adequate substitute for in-person learning (Niemi, & Kousa, 2020). Others referred to the little interaction, problems of infrastructure and lack of equipment (Mustafa, Yasemin & Selahattin,2020).

The results seem to be in line with (Azevedo, et al. 2022) who indicated that the global level of schooling and learning would fall substantially. School closures could result in a loss of between 0.3 and 1.1 years of schooling, bringing down the effective years of basic schooling that students achieve during their lifetime. Exclusion and inequality will likely be exacerbated of marginalized and at-risk groups, such as girls, ethnic minorities, and persons with disabilities.

This result is also consistent with country situation report issued by the Jordan Economic and Social Council (ESC, 2020) which explored that distance learning program does not adequately provide services for students, 50% of the technological equipment in schools is old, unsuitable, and does not accommodate distance learning.

The second research question sought if there are statistically significant differences at ($\alpha \leq 0.05$) in the sixth-graders' achievement in mathematics due to the COVID-19 pandemic.

T-test for single-sample analysis revealed that the hypothetical mean value was 32.51, which was compared to the mean of the sixth grade students' results in the schools in science for the previous three academic years 2016/2017, 2017/2018 and 2018/ 2019 as shown in Table 7 below:

Table 7: A one-sample T-test indicating the difference between the study sample mean and the hypothetical mean of the sixth-grade students in mathematics

		Hypothetical mean					32.51			
Axis	No of study sample	Mean	Difference in means	SD	df	T-value	Sig	Result		
Sixth grade students' achievement in math	73	25.42	-7.085	4.761	72	-12.71	.000	Significant		

Table 6 indicates that the mean of the study sample members was 25, 42 (SD 4.761) which is less than the hypothetical mean (32.51) for the sixth grade students by (7.085). When testing the

significance of the differences, it was statistically significant at $\alpha \leq 0.05$; subsequently, it can be concluded that there is a learning loss in the sixth-grade students' achievement in

mathematics, as there were significant differences between their achievement before and during the Corona pandemic.

This may be attributed to the novelty of the experience and students' lack of necessary electronic devices, in addition to the distractions that are a reality of online learning and teachers' lack of practical knowledge. The researcher believes that although the online learning has been given focus, the needs and requisites associated with the process is yet to be highlighted.

The result can also be attributed to non-authentic interaction and a lack of the spontaneity that in-person teaching provides (Niemi& Kousa 2020). It is also consistent with (story& Zhang 2021) who explored that students lose 15 % of learning during the pandemic school closures and their math achievement is somewhat more negatively

affected compared to reading achievement. The results also agreed with (Engzell et al. 2021) who reported a learning loss of about 3 % (0.08 SD) which is equivalent to one-fifth of a school year, in addition, losses are up to 60% larger among students from less-educated homes, where they have made little or no progress.

The third research question sought if there are statistically significant differences at ($\alpha \leq 0.05$) in the ninth-graders' achievement in science due to the COVID-19 pandemic. T-test for single-sample was conducted and revealed that the hypothetical mean value reached 34.21 and compared to the mean of the sixth grade students' results in science for the academic years 2016/2017, 2017/2018 and 2018/ 2019 as shown in Table 8 below:

Table 8: A one-sample T-test indicating the difference between the study sample mean and the hypothetical mean of the ninth-grade students in science

		Hypothetical mean					34.21			
Axis	No of study sample	Mean	Difference in means	SD	df	T-value	Siq	Result		
Sixth grade students' achievement in math	61	31.89	-2.325	3.624	60	-5.010	.000	Significant		

Table 8 indicates that the mean of the study sample members was 31, 89 (SD 3.624) which is less than the hypothetical mean (32.51) for the ninth grade students by (2.325). When testing the significance of the differences, it was found significant at $\alpha \leq 0.05$, which concluded that there is a learning loss in the ninth-grade students' achievement in science.

This result can be attributed to the fact that science is taught according to the active learning strategy in which students are actively or experientially involved in the learning process and in implementing different types of surveys (structured, guided, and free). Consequently, the unavailability of teaching and learning materials

and the difficulty of implementing experiments hinder the implementation of scientific activities which will negatively affect students' achievement and their mastery of educational competencies, in addition to the barriers of distance education, as a result, students' performance in science has declined.

This finding is consistent with the results of (Azevedo, et al. 2022, Engzell et al. 2021 Canovan' & Fallon, 2020) which all indicated that suspension of face-to-face instruction in schools during the COVID-19 pandemic has led to concerns about consequences for students' learning which had fallen behind by the

end of the school year in general and in science in particular.

The fourth research question sought if there are statistically significant differences at ($\alpha \leq 0.05$) in the ninth-graders' achievement in mathematics due to the COVID-19 pandemic.

T-test for single-sample was conducted and revealed that the hypothetical mean value

Table 9: A one-sample T-test indicating the difference between the study sample mean and the hypothetical mean of the ninth-grade students in mathematics

Axis	Hypothetical mean						T-value	Siq	Result
	No of study sample	Mean	Difference in means	SD	df				
Sixth grade students' achievement in math	61	28.11	-6.695	4.204	60	-12.44	.000	Significant	

Table 8 indicates that the mean of the study sample members was 28, 11 (SD 4.204) which is less than the hypothetical mean (34.81) for the ninth grade students by (6.695). When testing the significance of the differences, it was found statistically significant at $\alpha \leq 0.05$, which elucidate that there is a learning loss in the ninth-grade students' achievement in mathematics due to Covid 19 pandemic.

This result can be explained according to the nature of mathematics. As a practical matter, mathematics is a science of pattern and order, its domain is not molecules or cells, but numbers, algorithms and change. It is a science of abstract objects and relies on logic rather than on observation as means of discovering truth. Therefore, there is an urgent need to use illustrative means and tools when expressing mathematical ideas, and sometimes software such as Geo-Algebra, which are not available in distance education. In addition, teaching mathematics requires the teacher to deal with mathematical abstraction, specifically; figuring out efficient ways to translate abstract concepts into more easily understandable and accessible ideas for their students and create sufficient momentum to move them through which is no fun but is necessary.

reached 34.81, which was compared to the mean of the ninth grade students' results in the schools in mathematics for the previous three academic years 2016/2017, 2017/2018 and 2018/ 2019 as shown in Table 9 below:

This result can also be explained by the fact that mathematics teachers were unprepared for this sudden transition, they had a rather or totally inadequate level of digital competence to handle the distance education and reported a deficit in using digital tools, furthermore, they lack sufficient technical experience to manage the learning process remotely (King Salman Relief Center, 2020).

This finding is consistent with the results of (Hevia, et al.2020; Azevedo, et al. 2022, Engzell et al. 2021 story & Zhang, 2021) which concluded the evidence for a negative learning effect of COVID-19 induced distance education. In addition, school closures have led to a loss of learning compared to previous school years and negatively affected students' achievement in mathematics.

The fifth research question sought if there are statistically significant differences at ($\alpha \leq 0.05$) in learning loss during the Covid-19 pandemic according to the educational subject (science, mathematics)

To answer this question, the means and standard deviations of the two classes (science, mathematics) were calculated, and then the T-test for two independent samples was used to

compare the averages of two groups as shown in the table 10 below:

Table 10: means, standard deviations and T-test for the responses of the study sample according to science and mathematics subjects

Subject	No	Mean	SD	T-value	df	Sig
Science	134	30.31	4.516	6.510	266	.000
Mathematics	134	26.65	4.696			

Table 10 showed that (T) value reached (6.510), which is a statistically significant. The mean of the study sample in mathematics (26.65) is less than their mean in science (30.31). Subsequently, it can be concluded that there are statistically significant differences between the mean scores of the study sample attributed to the subject variable (science, mathematics).

Students' achievement in mathematics was affected by the learning loss resulted in Covid 19 and distance education. As mathematics is abstract and has a special structure, there is an urgent need that teachers be present in front of the students.

Despite the advantages of online learning,, nothing compares to mathematical interaction and the meaningful learning that comes from face-to-face instruction, such as seeing students struggle and supporting each other, hearing their laughter in real time, and seeing their faces light up when they finally understand something. Face to face schooling will never lose its importance because it is how people learn best, not behind a computer screen (Chetty et al., 2020).

The results seems to be in line with a plethora of research (see for example, (Hevia, et al.2020; Azevedo, et al. 2022, Engzell et al. 2021 story & Zhang, 2021; Canovan; Fallon,2020) which concur that remote learning unsurprisingly miss the connection of face-to-face contact that students used to with their peers and teachers.

4. Conclusion

The results of the study concluded that there is a learning loss among the study sample in science and mathematics during Covid-19 compared to the hypothetical average scores, it also revealed that losses are greater in mathematics than in science.

5. Recommendations

Based on the results of the current study, the researcher recommends the following:

- 1- Using instructional strategies to compensate for students' lack of prior learning by attempting to fill them in on what they have missed taking into consideration that (one size fit all) does not work in education and not all students learn effectively with the same the mechanism triggered.
- 2- Enhancing the digital educational environment to deal with students' individual differences, especially marginalized students who suffer from educational poverty.
- 3- Enhancing teachers' professional development to overcome technical difficulties through specialized training courses. School systems that attracted talented teachers before the crisis are the most effective in reducing learning losses (Chen et al (2021).
- 4- Developing educational platforms and digital tools compatible with science and mathematics subjects, which are characterized by a content of cumulative dimensions.

5- Ensuring the continuity of education through high-quality digital learning infrastructure and designing comprehensive and flexible treatments to enhance learners' different aspects, not just their academic achievement.

6- Returning to face-to-face education, since distance education will never be an adequate substitute for in-person learning which will stop and recover the bleeding of learning loss.

7- Focusing on students from the most vulnerable and marginalized groups.

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