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Examining Lebanese Secondary Students' Biology Learning Loss due to the Economic Crisis and COVID-19 Pandemic

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Abstract

The economic crisis and the COVID-19 pandemic since 2019 forced both public and private schools in Lebanon to close for an extended period of time. Many topics were suspended from the curriculum due to decreasing the number of learning days. The predominant causes of learning loss are lengthy gaps or cutouts in students' education. This study aims to investigate the impact of school closure on students' learning, specifically the learning loss in biology at the secondary level during the period between 2019-2022. This is a mixed research: qualitative data was collected through document analysis to compare the topics covered in biology and the official exams for grade 12-Life Science section during the last two academic years with those covered and implemented before the dual crisis; and quantitative data through teachers' questionnaire implemented to address the biology learning loss. The results revealed a huge learning loss in biology, more than 50 % of the biology program was not covered in grades 10, 11-S and 12-LS, and a decline in the quality of the official exams. Similar results were obtained in a parallel study addressing Lebanese secondary students' learning loss in mathematics.

Introduction

The term "*learning loss*" describes any specific or general loss of knowledge and/or skills, as well as academic progress reversals, most frequently brought on by prolonged gaps or discontinuities in a student's education (Todd & Romine, 2018). The predominant causes of learning loss are lengthy gaps or cutouts in student's education. Learning loss is likely to be among the most devastating effects school closures have on children (Angrist et al., 2021). School closure was responsible of learning loss that is related to students' motivation and achievement (Tikhomirova et al., 2020). Evidence indicates that *any* interruption in schooling, including scheduled vacations, can lead to a loss of learning for many children (Azevedo et al., 2021). The impact of school closure on academic outcomes is tied to the duration of the closure, students' learning outcomes will decline more rapidly the longer they are out of school (Chen et al., 2021).

Previous research examined the impact of summer recess on learning, or disruptions from events such as extreme weather conditions or teachers' strikes (Belot & Webbink, 2010). Suspension of face-to-face instruction in schools during the COVID-19 pandemic has led to concerns about consequences for students' learning

(Engzell et al., 2020). The lockdown during the COVID-19 pandemic has paralyzed education in the world in 2020, schools in many countries all over the world were forced to close for extended periods. According to the UNESCO, the United Nations Educational, Scientific and Cultural Organization, 1.3 billion student, approximately 72.4% of the students registered in schools and universities, were forbidden to attend their regular daily classes (Al Omian, 2020). Teaching and learning inside the classrooms were not options during the pandemic, so everyone resorted to the distance learning platforms. However, there is ample proof that students learn less during lockdowns than they would in a conventional school year (Engzell et al., 2020). According to Zierer (2021) school closure due to COVID-19 pandemic lead to decrease in students' learning performance across all disciplines and for all ages in the countries under study: USA, Belgium, Netherlands, Switzerland and Germany. Another study indicated a learning loss in Ethiopia, Liberia, Kenya, Tanzania, and Uganda of between half a year and one year (Angrist et al., 2021). The research revealed yet another crucial quantification regarding the impact of the COVID pandemic on learning outcomes. According to this study, if urgent action is not taken after the re-opening of schools, learning losses could affect students for a lifetime because these losses can accumulate over time. For example, a child in grade 3 could experience a short-term learning deficit that would amount to 2.8 years of lost learning by grade 10 (Angrist et al., 2021).

When remote learning was initially implemented in reaction to school closures between March and July of 2020, teachers were surveyed in eight nations (Australia, Canada, China, France, Germany, Japan, the United Kingdom, and the United States) and asked to judge its efficacy on students' learning. On average, teachers gave remote learning five out of ten. The grades were especially harsh from teachers in Japan and the United States, where nearly 60 percent rated the effectiveness of remote learning between one and three out of ten. Teachers working in high poverty schools found remote learning ineffective rating it 3.5 out of 10 due to lack of ability of students to access internet or to owe specific devices suitable for remote learning (Chen et al., 2021).

Lebanese Educational Context between 2019-2022

According to the world bank (World Bank, 2020) the actual number of years that children in Lebanon are learning at schools is 6.3 years although the average years of schooling is 10.2 years. So, a loss of 3.9 years can be detected during the educational pathway of students in Lebanon in the normal situations. Moreover, there is social and quality disparities between schools and regions; Lebanon has a dual system, with public education luring lower middle-class and impoverished social groups and private education luring middle-class and higher middle-class groups, with significant quality discrepancies between the two (Frayha, 2009). The already troubled Lebanese educational system has been severely strained by the numerous crises that have hit Lebanon over the past few years, including the COVID-19 pandemic, the flood of Syrian refugees, the economic and financial crisis, and the Port of Beirut explosion (World Bank, 2021). The most recent school closures were due to the COVID-19 pandemic, with schools being closed over 75 percent of the school year between January 2020 and February 2021. This will likely lead to a further and significant decrease in learning (Azevedo et al., 2021).

During the academic year 2019-2020, Lebanon witnessed the eruption of the evolution on October 17, 2019 due to the harsh economic and financial crisis, in addition to the COVID-19 lockdown which started on March 3,

2020. The dual crisis caused school closure for extended period of time. According to a recent United Nations report, the education of at least 1.2 million students in Lebanon has been interrupted in 2020, leading to increased dropout rates (ERP, 2021). Many students have not attended school since October 2019 as a result of protests, the COVID lockdown, and civil upheaval (Ndeda & Smith, 2021). The Lebanese Ministry of Education and Higher Education (MEHE) announced the end of the academic year in May, 2020 and cancelled the official exams for grades 9 and 12 allowing students to move into the next levels immediately, similarly, students in all grades were automatically promoted to higher classes. The Lebanese official exams for 12th graders are the gateway for students to enroll in universities and colleges. The suffer of the Lebanese students and the educational sector did not stop within one year where the lockdown continued through the country affecting the academic year 2020-2021.

During the academic year 2020–2021 different steps were taken by MEHE (Ministry of Education and Higher Education) in collaboration with the Center for Educational Research and Development (CRDP). The CRDP is responsible for studying educational curricula, suggesting appropriate ones, specifying the topics and objectives required in all subjects and in grade levels. In addition, CRDP is responsible for approving the pattern of official examination questions. The curriculum content was reduced to around 50% trying to ensure that only the essential competencies are given to students, the number of academic weeks of schools were reduced as well. According to estimates, during this academic year the students used a hybrid strategy of online and in-person attendance for just 11 weeks of instruction up until March 2021. Thus, students who have attended some form of school during this academic year have now progressed a year in their education, however, they need catch-up classes of at least 6-8 weeks according to MEHE (Ndeda & Smith, 2021). Moreover, the official exams of the academic year 2020-2021 for grade 9 students were cancelled again while the official exams for G 12 students were postponed from June-2021 to July-2021. For the first time, grade 12 students underwent their exams with reduced curriculum-content on one hand and reduced curriculum-subject on the other hand. Thus, school closures due to COVID pandemic and the economic crisis might not only affect the learning of students but also the quality of the official exams in Lebanon.

On the other hand, the online learning experiment that was conducted in Lebanon during the Corona virus crisis was unsuccessful. The main causes of this failure were the slow internet connection, the power outages, the lack of participation of the students, teachers' abilities, as well as difficulties with student assessment (Rouadi & Anouti, 2020). Teachers and students agreed that the quality of education declined after adapting distance learning during COVID-19 lockdown. The poor quality of education was mainly due to the overall reduction in the number of teaching days and hours, due to the teachers' week experience in distance learning, and difficulty to reach teaching objectives (Hammoud & Shuayb, 2021). According to CRDP (2021), the maintenance of devices, the high cost of internet, bad internet connection, electricity cutoffs, and the availability of digital educational resources influenced the curriculum achievement during online learning.

The academic year of 2021-2022 was another challenging year for teachers, schools, parents, and students. Centre for Lebanese Studies (CLS) surveyed the impact of the economic and corona crisis on the educational sector in Lebanon to assess school, parent, student, and teacher readiness for the challenges of the new academic

year 2021-2022. The study found that both public and private schools, students, parents, and teachers are not prepared to return to traditional classroom settings or online learning for the academic year 2020-2021 because of Lebanon's present financial crisis (Hammoud et al., 2021). The anticipated percentage of the Lebanese population living in poverty in March 2021 is 78% (3 million).

Many schools are now unable to pay their teachers as a result of the economic crisis. In addition, parents and teachers view the difficulty of commuting to school because of the fuel crisis as a top worry for returning to in-person learning. Thus, the economic crisis has added to the workloads of schools, teachers, and parents, and it has increased the likelihood that students would not receive proper education for a third year in a row (Hammoud et al., 2021). Despite all that, MEHE did not work on an urgent plan, a strategy, or a distinct vision for how to deal with the numerous issues that influence the educational sector. In order to avert teachers' strikes, the MEHE's main crisis management approach has depended on imperfect solutions. The ministry has been threatening teachers with disciplinary penalties if they don't show up to work because transportation is too expensive while promising them small financial compensations (Hammoud & Shuayb, 2022).

Conceptual Framework

Extended school closure in Lebanon during the period between 2019 and 2022 due to the 2019 revolt, COVID lockdown, economic crisis, and teachers' strikes (Hammoud & Shuayb, 2022) forced the MEHE in collaboration with CRDP to suspend many topics and lessons from the curriculum and from the official exams which affected students' knowledge and practices leading to learning loss. For the purpose of this study we focused on three main constructs that affect learning loss: the curriculum content, teachers' practices, and assessment. The biology curriculum content was reduced due to the dual crisis in Lebanon; school closure during this period affected teachers' practices, students' knowledge and skills, as well as the quality of the official exams used as standardized assessment. Figure 1 below shows the conceptual framework of the study elaborated by the researcher.

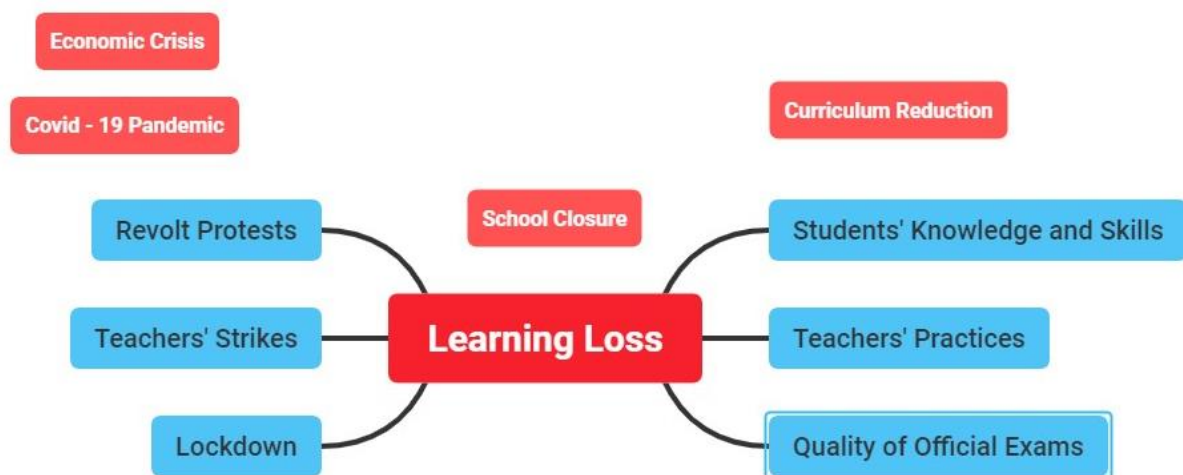


Figure 1. Conceptual Framework of the Study

Significance of the Study

Previous studies were performed to investigate the impact of the Corona pandemic on education and the efficiency of online learning. However, there is a research gap in Lebanon concerning the effect of school closure due to the economic crisis and the Corona pandemic on students' learning during the last three academic years from 2019-2022. This study will highlight the topics/ chapters/lessons suspended in biology at secondary level; the level of complexity of the biology official exams; and the knowledge lost from the perspective of teachers during this period.

The findings of this study will inform policy makers about the biology learning loss, this will aid them to develop a plan based on students' needs. The results will highlight the knowledge gaps in biology for secondary students, this will aid teachers to develop strategies to compensate the students' learning loss. Moreover, researchers can conduct similar studies to investigate learning loss in different subjects and in different classes.

Purpose of the Study and Research Questions

This study aims to investigate the impact of school closure due to COVID pandemic and the economic crisis on Lebanese students' learning. It specifically targets secondary students' learning loss in biology during the last three academic years: 2019-2020, 2020-2021 and 2021-2022. The research addressed the following questions:

1. What is the biology learning loss of secondary students in terms of content?
2. What is the biology learning loss of secondary students based on teachers' experience? How do private and public schools compare?
3. What is the biology learning loss of secondary students in terms of quality of the biology official exam for grade 12- Life Science?

Method

This study is a mixed research where both quantitative and qualitative data were collected. It implements a concurrent exploratory design. Quantitative data was collected through teachers' questionnaire and qualitative data through official document analysis.

Sample of the Study

The study targeted biology secondary teachers in both private and public school from different Lebanese regions. 47 biology secondary teachers filled the questionnaire voluntarily, with a teaching experience ranging from 3 to more than 20 years. Despite sending the questionnaire to WhatsApp groups for biology teachers across various regions, the majority of the teachers who responded were from Mount Lebanon. In Lebanon, the majority of secondary teachers work in both public and private institutions, which is unusual globally. Table 1 below shows the profile of the sample.

Table 1. Profile of the Participant Teachers

Variables		N
Type of school	Public	14
	Private	22
	Both	11
Governorate	Mount Lebanon	22
	Beirut	5
	North	5
	South	8
	Bekaa	7

Data Collection Tools

Several data collection tools were utilized for triangulation purpose including: Teachers' questionnaire, official documents related to biology content, and official exam documents. The questionnaire was established and validated by the researcher in collaboration with a math educator and a biology teacher with a teaching experience of more than 10 years. Documents issued by CRDP related to topics/ chapters and lessons required and suspended in biology for secondary classes before, during and after the Corona pandemic and the economic crisis were compared. The comparison was performed specifically for the biology content of: G10 the first secondary class which is common for all high school students; G11 Scientific section (G11-S), the second secondary class where the emphasis is on the scientific subjects; and G12- Life Science section (G12-LS), the third secondary class where the emphasis is mainly on biology in addition to other scientific subjects. Moreover, the three official exams for G12-LS performed in 2019, 2021, and 2022 were analyzed and compared to investigate the effect of school closure on the quality of official exams. It is worth noting that Lebanese official exams in 2020 were canceled due to the outbreak of COVID, as well as the eruption of the Lebanese Revolution.

Teachers' Questionnaire

The questionnaire was implemented to collect data related to biology learning loss of Lebanese secondary students from the perspective of biology secondary teachers. Secondary students' learning loss was investigated since it might affect their further education and profession (Suroyo et al., 2021). Content validity was verified through building the items of the questionnaires in alignment with the biology curriculum content issued by CRDP. Face validity was established through a read aloud strategy done by an expert colleague in biology education after building up the items. The expert was required to read aloud each item in the questionnaire and reflect on it. The questionnaire was piloted before implemented as google form.

The final version of the questionnaire is composed of four sections:

- 1- Demographic information: teaching experience, type of school, place of school.
- 2- Online learning: platform used, content covered, students' equality.

- 3- Topics not covered in biology during the academic years: 2018-2019, 2019-202,2020-2021, and 2021-2022, in grades 10, 11-S and 12-LS; Percentages of the program covered.
- 4- Open ended questions related to students' learning loss according to type of school (public or private), and region.

In the third section, the teachers were supposed to check what they did not cover in the last four academic years in their public or private schools or both from all the topics/ chapters, lessons of the biology program in secondary classes, G10, G11-S, G12-LS.

Official Documents Utilized

Three main documents issued by CRDP were analyzed to compare topics/chapters and lessons/activities suspended during the academic years 2018-2019, before the pandemic and the economic crisis, and the academic years 2020-2021 and 2021-2022 during and after the crisis and pandemic. The first document analyzed is an explanatory guide on the topics and chapters that has been suspended or added for the academic year 2018-2019 until the release of the developed curricula, for the Teaching subject: life and earth sciences / life sciences, based on the Circular No. 28/m/2018, date 21/5/2018 (CRDP, 2019).

The second document presents the basic educational contents and the basic scientific content related to the basic objectives of Life and Earth Sciences/Life Sciences for the academic year 2020-2021 exclusively. These amendments are based on Circular No. 30/m/2020 dated 16/9/2020 related to determining the basic objectives of languages and the basic topics for the rest of the subjects, for the academic year 2020-2021 exclusively (CRDP, 2021). The third document presents the basic educational contents and the basic scientific content related to the basic objectives of Life and Earth Sciences/Life Sciences for the academic year 2021-2022 exclusively. These amendments are based on Circular No. 13/M/2021 dated 08/23/2021 related to determining the basic objectives of languages and the basic topics for the rest of the subjects, for the academic year 2021-2022 exclusively (CRDP, 2022 b).

Data Analysis

The data collected from the questionnaire was analyzed using SPSS program, both descriptive and inferential analysis was performed. The topics/chapters and lessons of biology required and suspended were compared utilizing the official documents issued by CRDP before during and after the pandemic and crisis. The official exams of Grade 12-LS implemented in 2021 and 2022 were compared to the exam in 2019 implemented before Corona pandemic and the economic crisis, knowing that in 2020 no official exams were performed because of the lockdown and school closure.

Criteria for the Analysis of the Official Exams

The documents of the official exams were analyzed based on the specific characterization of the official exam

materials elaborated by the CRDP (CRDP, 2017 a). According to the purpose of the study, content coverage, and coverage of the three domains according to the official instructions for “Life Science” examination, were compared. In addition, the exercises were analyzed based on the levels of Blooms’ taxonomy.

According to the characterization of the official exam materials (CRDP, 2017 a), the exam of G12-LS should include 4 exercises covering 70% of the program, however, the same objective should not be assessed more than once. The exercises are independent and meant to test the competencies of the three domains, the exercises of the exam can combine one or many competencies of different domains. Each exercise can assess one or several topics of the mentioned program. The three domains assessed are: A- Mastering acquired knowledge; B- Practicing scientific reasoning; D- Mastering communication techniques, as represented in the figure 2 below (CRDP, 2017 b). The exam is over 20: 3 points maximum for Domain-D, and the remaining points should be distributed on Domains A and B taking into consideration that most competencies in each domain should be covered.

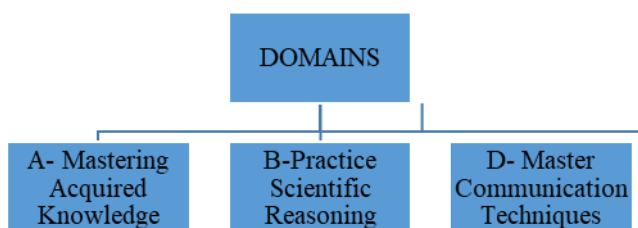


Figure 2. The Three Domains Assessed in the Official Exams

Each domain compromises certain competencies: Domain A competencies are presented in figure 3; Domain B competencies in figure 4; and domain D in figure 5.

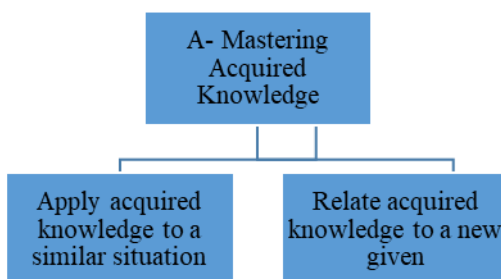


Figure 3: Domain- A Competencies

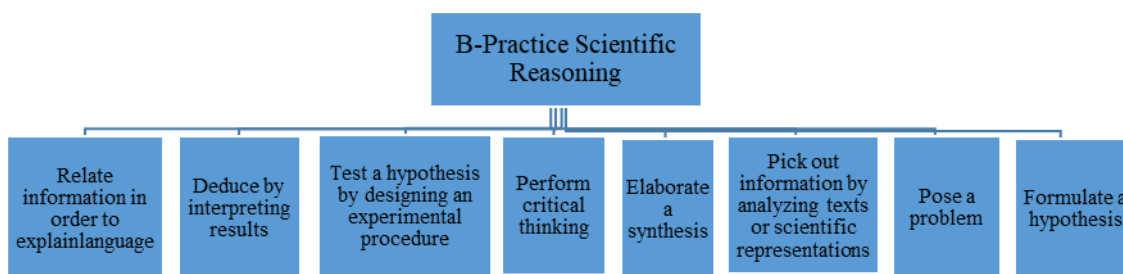


Figure 4: Domain- B Competencies

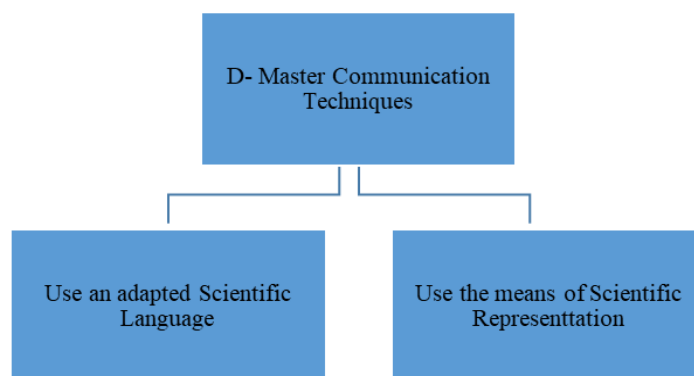


Figure 5. Domain- D Competencies

Moreover, the questions were evaluated according to Blooms' Taxonomy presented in figure 6 to infer the level of complexity of the official exams. For validity purpose, the analysis of the three exams performed by the researcher was shared and discussed with a biology expert and remarks given were taken into consideration.

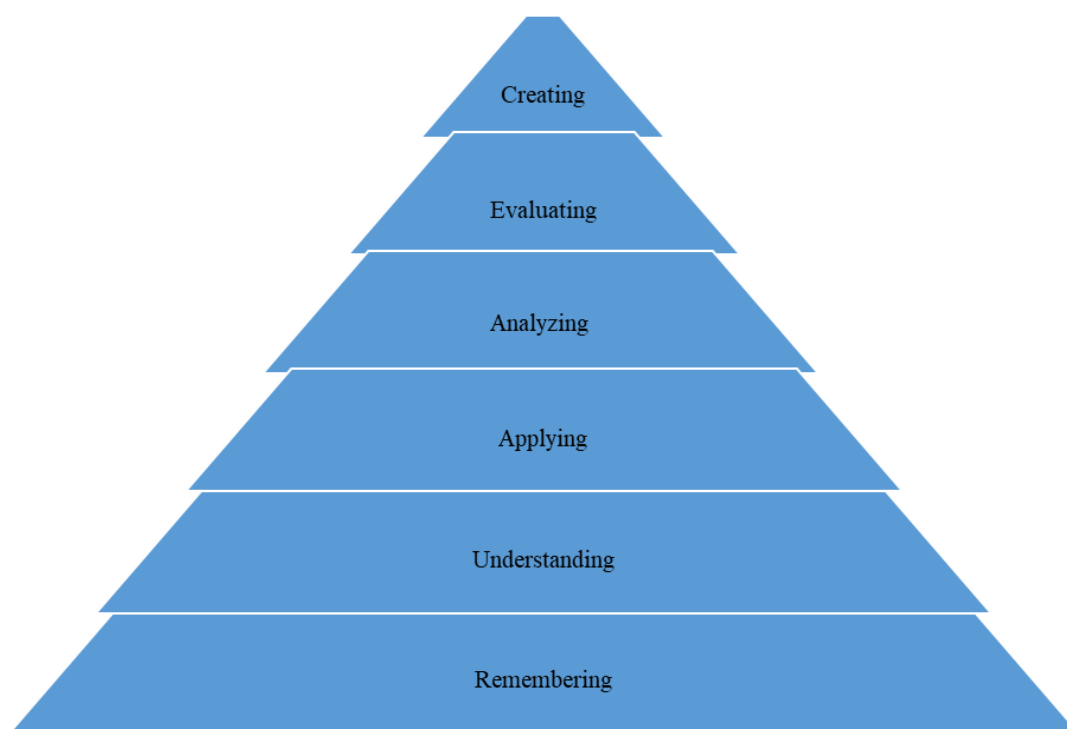


Figure 6. Levels of Blooms Taxonomy

Results

Students' Learning Loss in terms of Content

In order to infer secondary students' learning loss in biology in terms of content, the required and suspended topics/ chapters, lessons/ activities for G10, G11-S and G12-LS, were compared utilizing three official documents issued by CRDP. The comparison was done between the three academic years of 2018-2019 before the pandemic and the economic crises and the academic years 2020-2021 and 2021-2022. It is worth noting that

no official documents were issued in 2019-2020, however, during this year schools closed for long periods because of the protests that started on October 17, 2019, and then due to the Corona lockdown which started in March 3, 2020 and the school was ended by MEHE in May, 2020. In 2020-2021 the topics were distributed over 13 weeks to 15 weeks, while in 2021-2022 the topics were distributed over 18 weeks, knowing that in normal school years the program is distributed over 24 to 28 weeks.

Biology Content for Grade 10

The required and suspended topics/ chapters and lessons/ activities for G10 during the academic years 2018-2019 (before the crisis), 2020-2021, and 2021-2022 are presented in table 2 below. The comparison of the biology content for G10 shows the suspension of many important lessons in 2021-2022, few lessons were reintroduced in 2021-2022. In 2018-2019, 25 lessons were required compared to 13 lesson in 2020-2021 and 19 lessons in 2021-2022. Thus 48 % of the content was suspended in 2020-2021 and 24 % in 2021-2022. In 2020-2021 the whole unit about “Nutrition and Structure of Chlorophyllic Vascular Plants” was suspended except the lesson of “Photosynthetic Gaseous Exchange”. However, in 2021-2022 the chapters about “Plant Supply with Raw Material”, and “Use of Photosynthetic Products” were reintroduced. In the unit related to “Plant Production and Environmental Factors”, the lesson about “the Influence of Light and Carbon Dioxide on the Intensity of Photosynthesis” was suspended in 2021 and still suspended in 2022. However, this topic is important for students to understand the necessary conditions for better plant productivity (CRDP, 2019).

In the topic related to “Water pollution”, the lesson related to “Evaluation of Running Water Pollution” were suspended in 2021 and still suspended in 2022. However, according to CRDP (2019) this is essential for students to understand how to protect the environment. Knowing that the lessons related to “Variation in the Quality of Running Water and auto purification” were also suspended before the crisis. In the topic related to “Management and Protection of Fresh Water”, the lessons related to “Precipitation and Infiltration” were suspended in 2021 and still suspended in 2022. However, this is important for students to understand the properties of rocks that allow the conservation of filtered water. Also, the idea about “Intensive Exploitation of Water” which is important for the students to understand how to conserve the water layers and their use was suspended (CRDP, 2019). Finally, the topic of “Reducing Agricultural Pollutants” which is important to inform the students on the methods to follow in protecting the environment and reduce the pollution (CRDP, 2019) was also suspended in 2021 and 2022.

Table 2. Comparison of the Biology Content Required and Suspended for G10

Chapter number	Chapter title	Activity number	2018-2019	2020-2021	2021-2022
Ch1	Autotroph & photosynthesis	Act 1-2	Newly suspended	Still suspended	Still suspended
		Act 3-4	✓	✓	✓

Ch2	Plant Supply with raw materials	Act 1-2-3-4	✓	Newly suspended	✓
Ch3	Use of Photosynthetic Products	Act 1-2-3	✓	Newly suspended	✓
Ch4	Nervous Communication	Act 1 to 4 & 7	✓	✓	✓
		Act 5-6-8	Newly suspended	Still suspended	Still suspended
Ch5	Hormonal Communication	Act 1	Still suspended	Still suspended	Still suspended
		Act 2&3	✓ Reintroduced	✓	✓
Ch6	Production of high quality plants	Act 1-2-3-4	Still suspended	Still suspended	Still suspended
Ch7	Environmental Factors	Act 1-3-4	✓ Reintroduced	✓	✓
		Act 2	✓ Reintroduced	Newly suspended	Still suspended
Ch8	Water Pollution	Act 1&2	✓	Act 2 newly suspended	Act 2 Still suspended
		Act 3	Newly suspended	Still suspended	Still suspended
Ch9	Management of fresh water	Act 4 & 5	✓	✓	✓
		Act 1,2 &4	Suspended	Still suspended	Still suspended
		Act 3 &5	✓	Suspended	Still suspended
		6 & 7	Still suspended	Still suspended	Still suspended
Ch10	Management of Soil	8	✓ Reintroduced	Suspended	Still suspended
		Act 1 to 6	Still suspended	Still suspended	Still suspended

Biology Content for G 11-S

The required and suspended topics/ chapters and lessons/ activities for G11-S during the academic years 2018-2019 (before the crisis), 2020-2021, and 2021-2022 are presented in table 3 below.

Table 3. Comparison of the Biology Content Required and Suspended for G11-S

Chapter number	Chapter title		2018-2019	2020-2021	2021-2022
Ch1	Diversity of Organisms	Act 1-4	Newly suspended	Still suspended	Still suspended
		Act 2-3	Newly suspended	Still suspended	Still suspended
Ch2	DNA & Cell Cycle	Act 1-2-3-4	✓	✓	✓
		Act 1 to 5	✓	✓	✓
Ch3	Protein Synthesis	Act 6-7	✓	Newly suspended	Still suspended
		Act 8	✓	suspended	✓
Ch4	Biological Identity	Act 1-2-3	Newly suspended	Still suspended	Still suspended
Ch5	Molecular Renewal	Act 1-2	Newly suspended	Still suspended	Still suspended
Ch6	Energy Expenditure	Act 1-2-3	✓	✓	✓
		Act 1-2-3-4	✓	suspended	Still suspended
Ch7	Energy of the Cell Functioning	Act 1-3-4-5	Reintroduced	suspended	Still suspended
		Act 2	Reintroduced	✓	✓
Ch8	Metabolism in Man	Act 1-2-3	✓	suspended	Still suspended
Ch9	Diversity of feeding habits	Act 1-2-3-4	✓	✓	✓
Ch10	Balanced diet	Act 1-2-3-4	✓	✓	✓

Ch11	Nutritional Diseases	Act 1-2-3	✓	Newly suspended	Still suspended
Ch12	Light to chemical energy	Act 1 to 5	Still suspended	Still suspended	Still suspended
Ch13	Energy Flow in Ecosystem	Act 1-2-3-4	Still suspended	Still suspended	Still suspended
Ch14	Man & the carbon cycle	Act 1-2-3	Newly suspended	Still suspended	Still suspended

The comparison of the biology content shows the suspension of many important lessons in 2020-2021, just one lessons was reintroduced in 2021-2022. In 2018-2019, 34 lessons were required compared to 17 lesson in 2020-2021 and 18 lessons in 2021-2022. Thus 50 % of the program was suspended in 2020-2021 and 2021-2022. In the chapter of “Protein Synthesis”, the lessons about “Enzymes as biological catalysts, and Reaction rate and optimum conditions” were suspended in 2021 and 2022, since objectives related to them are covered in G9 according to CRDP (2019). The whole chapter about “Energy of the Cell Functioning” was suspended in 2021 and 2022. In the chapter of “Energetic Metabolism in Man”, the lessons about “Nature of Metabolites”; “The Muscle Fiber and its Metabolism”, and “The Restoration of ATP” were all suspended in 2021 and 2022. The whole chapter of “Diversity of Feeding Habits” was suspended in 2021 and 2022 even though the topic is an important prerequisite for chapter 10 about balanced food diets (CRDP, 2019). The whole chapter about “Nutritional Diseases” was suspended in 2021 and 2022. Despite the fact that these topics are very important as awareness for learners in this age (Health style) according to CRDP (2019).

Biology Content for G 12-LS

The required and suspended topics/ chapters and lessons/ activities for G12-LS during the academic years 2018-2019 (before the crisis), 2020-2021, and 2021-2022 are presented in table 4 below. The comparison of the biology content shows the suspension of many important lessons in 2021-2022, just one chapter about “Birth control” was reintroduced in 2021-2022. 57 lessons were required for the official exams in 2018-2019, compared to 39 lessons in 2021 and 42 lessons in 2022. Thus, around 31.5 % of the biology program was suspended in 2021 and 26 % in 2022. However, it is worth noting that in the academic year 2020-2021 the topic of ‘Immunology’ (chapters 6 & 7; 15 lessons) were suspended before the official exams because of the unexpected school closure due to teachers’ strikes, especially the public schools. During the academic year 2021-2022 the topic of ‘Neurophysiology’ (Chapters 9 & 12; 8 lessons), and chapter 16 about ‘Birth control’ (3 lessons) were suspended before the official exams also due to unexpected school closure. Thus, the cumulative suspension related to the official exams in 2021 was 58 % in 2021 and around 46 % in 2022.

In “Reproduction”, all the lessons related to male reproduction were suspended including the lessons about “Male reproductive system” and “Spermatogenesis”. Knowing that it is essential for students to understand the basic mechanisms of sexual reproduction (CRPD, 2022 b). In “Heredity”, the lessons about “Inter and Intra-

chromosomal recombination” including dihybrid cross, transmission of two genes or two anomalies at the same time were suspended. This simplifies the topic since students will not be able to understand in their future studies that many phenotypes are determined by more than one gene and specifically certain hereditary diseases like Albinism. In “Mutation” the lesson of “Mutation and Environment” was suspended, which is Important to understand the effect of environmental factors on genetic diversity (CRPD, 2022 b). This also might affect students’ understanding of the importance of the environment on gene expression. In “Immunology”: the lesson related to “Blood grouping and Blood Transfusion” which is essential for students’ to understand the importance of compatibility of blood groups in case of blood transfusion was suspended. Everything related to disorders of the immune system was suspended: “AIDS; Hypersensitivity; and Auto Immune Diseases”, which are essential for students to relate what they study to their daily life. Moreover, during 2020-2021 the whole topic of immunology was not included in the official exams and was not covered by many public and private schools. In “Neurophysiology”, the topic of “Myotatic reflex” was suspended so students lost the knowledge related to posture, involuntary reflexes and how they are coordinated and can be controlled. In addition, the lesson about the “Nervous pathway of pain” which is important for students to understand that pain can be controlled by higher centers in the brain was also suspended. It is worth mentioning that the concepts related to the brain centers and voluntary motor activities were also suspended before the crisis in 2018-2019. In “Regulation” the chapter related to “Birth control” was suspended and not included in the official exams. However, this topic is important for students to relate what they study in reproduction and regulation of female cycle to their daily life.

Table 4. Comparison of the Biology Content Required and Suspended for G12-LS

Title of chapter		2018-2019	2020-2021	2021-2022	
Ch1	Act 1	✓	Suspended	Still suspended	
	Basic Mechanism of sexual reproduction	Act 2&4	✓	Suspended	Still suspended
	Act 3-5-6	✓	✓	✓	
Ch2	Transmission of Genes	Act 1-2	✓	✓	
	Act 3-4	✓	Newly suspended	Still suspended	
Ch3	Genetic Variation & polymorphism	Act 1&3	✓	suspended	Still suspended
	Act 2-4-5	✓	✓	✓	
Ch5	Human Genetics	Act 1	✓	Suspended	Still suspended
	Act 2-3-4-5	✓	✓	✓	
Ch6	Components of immune system	Act 2	✓	Newly suspended	Still suspended
	Act 1&3 to 7	✓	Suspended in Feb 2021	✓	
Ch7	The immune Response	Act 1 to 8	✓	Suspended in Feb 2021	✓
Ch8	Disorders of the immune system	Act 2	Newly suspended	Still suspended	Still suspended

		Act 1 &3	✓	Suspended	Still suspended
Ch9	Function of Neurons	Act 1 to 6	✓	✓	✓
Ch10	Myotatic Reflex	Act-1-2-3	✓	Suspended	Still suspended
Ch11	Motor Activity	Act 1-2-3-4	Newly suspended	Still suspended	Still suspended
Ch12	Neurotransmitters & Medical Applications	Act 1&4	✓	✓	✓
		Act 2&3	✓	Suspended	Still suspended
Ch13	Regulation of Glycemia	Act 1 to 6	suspended	Still suspended	Still suspended
Ch15	Regulation of Female Sexual Hormones	Act 1-2-3-4	✓	✓	✓
Ch16	Birth Control	Act 1-2-3	✓	Suspended	Suspended before the official exams

Students' Learning Loss Based on Teachers' Experience

To investigate secondary students' learning loss in biology from the perspective of biology teachers, a questionnaire was elaborated and validated by the researcher. The Google form of the questionnaire was distributed using social media: WhatsApp, Facebook, and Instagram. The questionnaire was filled by 47 biology secondary teachers voluntarily from both public and private schools in different regions in Lebanon.

According to the data collected from the questionnaire, 70 % of the participant teachers declared that their schools closed due to the economic protests that started in October-2019. According to the participants the period of school closure ranged from few days to few months. In the same year the Corona lock down started in March, 2020 and MEHE ended the school year in May, 2020. During the period between March and May, 2020 the participant teachers communicated with their students using various platforms and social media: Zoom, Google Classroom, WhatsApp etc...However, 65 % of the participants agreed that students did not have an equal chance to follow online classes, and 52% were able to cover the required content, with no significant difference between public and private schools.

When asked to specify the topics covered in G 10, only 13 %, 10.5 % and 6 % of public school participant teachers mentioned that they covered all the required topics in the academic years 2019-2020, 2020-2021 and 2021-2022 respectively. Similarly, only 8.5 %, 8.5 % and 6 % of private school teachers mentioned that they covered all the required topics in the academic years 2019-2020, 2020-2021 and 2021-2022 respectively.

Related to the biology program for G 11-S, only 10.5 %, 8.5 % and 6 % of public school teachers mentioned that they covered all the required topics in the academic years 2019-2020, 2020-2021 and 2021-2022

respectively. Similarly, only 8.5 %, 4 % and 8.5 % of private school participant teachers mentioned that they covered all the required topics in the academic years 2019-2020, 2020-2021 and 2021-2022 respectively. However, related to the biology program for G 12-LS, the results showed that the majority of the participants, 87 % of public school teachers and 95 % private school teachers covered all the topics required for the official exams during the academic years 2020-2021 and 2021-2022.

Biology Program Covered in G10 based on Participant Teachers' Experience

To infer students' biology learning loss based on the teachers' experience, the participants were asked to specify the percentage of the biology program they covered during the four academic years: 2018-2019, 2019-2020, 2020-2021, and 2021-2022, in grades 10, 11-S and 12-LS. 2018-2019 was considered as a reference, knowing that the pandemic and the economic crisis affected the educational sector since the academic year 2019-2020. During the academic year 2019-2020 schools closed for long periods because of the protests that started on October 17, 2019, and then due to the Corona lockdown which started on March 3, 2020.

The participants answers related to the biology program covered in G10 are represented in figure 7 below. According to 64 % of teachers in both public and private school 50% and less of the biology program was covered in 2019-2020, and 25.5 % of the participant teachers covered between 50 and 75 % of the program. Similarly, in 2020-2021, 57.4% of the participants answered that 50 % or less of the program was covered, and 25.5 % answered that between 50 and 75 % of the program was covered. In 2021-2022, 51% of the participants answered that 50 % or less of the program was covered, 23.5 % answered that between 50 and 75 % of the program was covered. Moreover, the results show that in the four academic years the percentages covered in public schools is less than in private ones. Chi square tests were performed to infer any relation between type of school and content covered, p values were less than 0.05. Thus, there is an association between these two variables, less biology content was covered in public schools from 2018 till 2022 in G10.

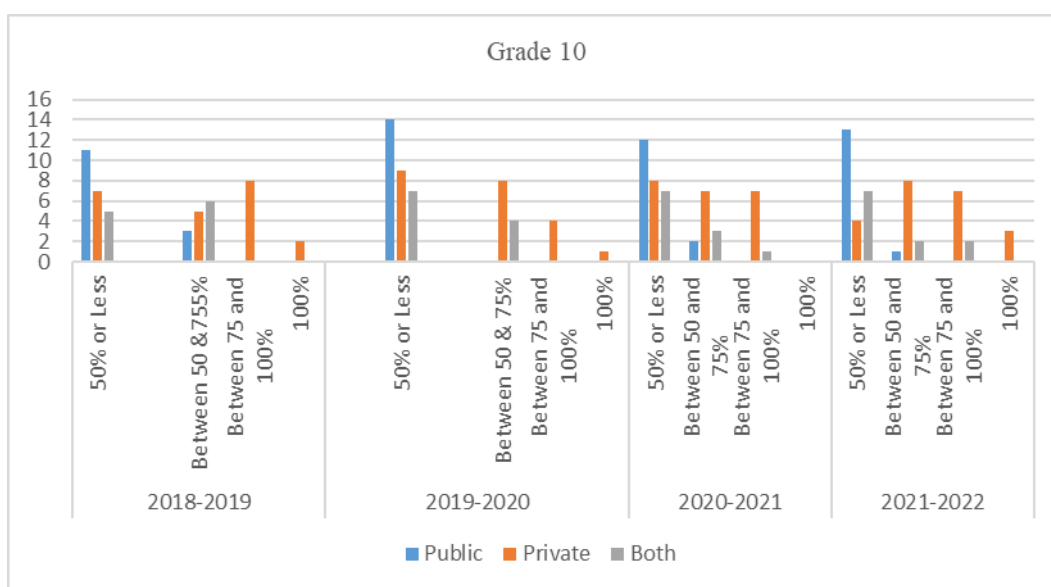


Figure 7. The Percentage of Biology Program Covered in Grade 10 according to Participant teachers

Biology Program Covered in G11-S based on Participant Teachers' Experience

Figure 8 shows the percentage of the biology program covered in G 11-S from the perspective of participant teachers. The results show that less content was covered from 2019-2022 compared to academic year 2018-2019 before the pandemic and the economic crisis.

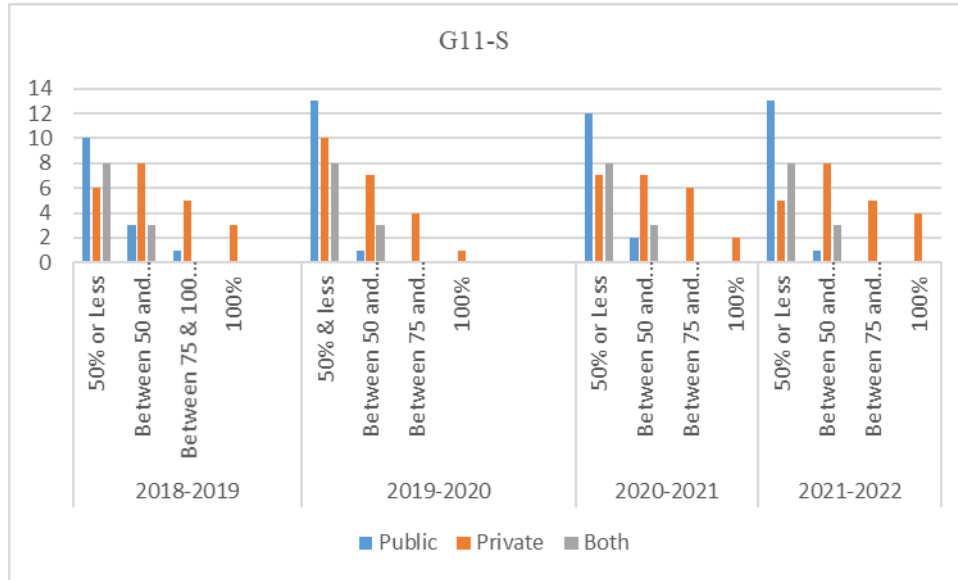


Figure 8. The Percentage of Biology Program Covered in Grade 11-S according to Participant teachers

Data analysis reveals that in 2019-2020 50 % and less of the biology program was covered according to 66 % of teachers in both public and private school, and between 50 and 75 % according to 23.5 % of the participant teachers. Similarly, in 2020-2021, 57.4% of the participants answered that 50 % or less of the program was covered and 25.5 % answered that between 50 and 75 % of the program was covered. However, in 2021-2022, 55% of the participants answered that 50 % or less of the program was covered and 25.5 % answered that between 50 and 75 % of the program was covered. The Chi square was performed, in 2018-2019, 2019-2020 the p values were > 0.05. However, in 2020-2021 and 2021-2022 the p values were < 0.05. Thus, again we can say that there is an association between the type of school and percentage of biology content covered in favor to private schools.

Biology Program covered in G12-LS based on Participant Teachers' Experience

Figure 9 shows the percentages of the biology program covered in G12- LS from the perspective of the participant teachers. Results revealed that in 2019-2020 50 % and less of the biology program was covered according to 42 % of participant teachers in both public and private school, and between 50 and 75 % according to 28 % of the participant teachers. Similarly, in 2020-2021, 45 % of the participants answered that 50 % or less of the program was covered, and 17 % answered that between 50 and 75 % of the program was covered. However, in 2021-2022, 36 % of the participants answered that 50 % or less of the program was covered, and 17 % answered that between 50 and 75 % of the program was covered. The chi-square tests performed showed that in 2018-2019, 2019-2020, and 2021-2022 the p values were > 0.05. However, in 2020-2021 the p value was

< 0.05 . This indicates that there is no association between school type and percentage of program covered in G 12-LS. This can be attributed to the fact that teachers in both public and private schools should cover the requirements for the official exams that students of G12 should pass in order enter the university.

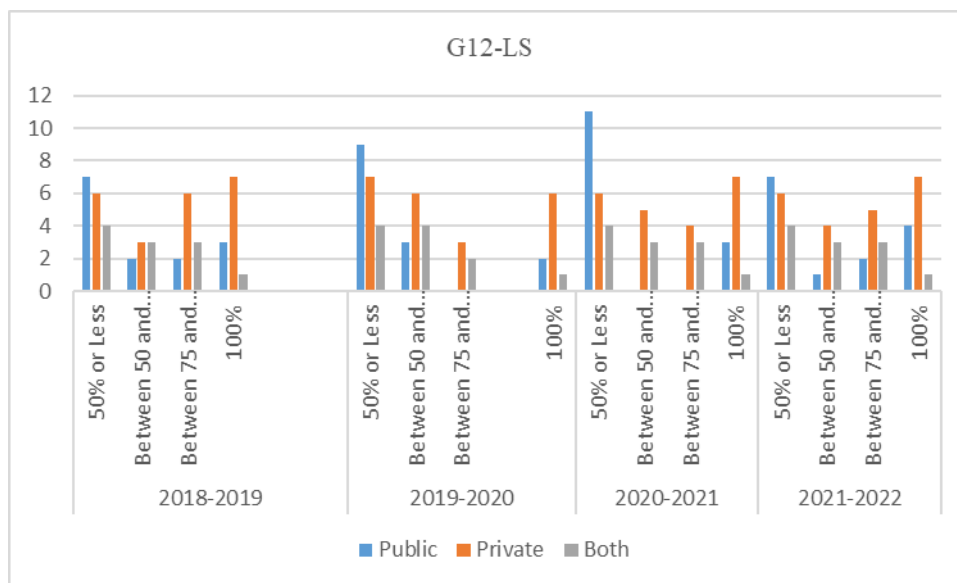


Figure 9. The Percentage of Biology Program Covered in G 12-LS according to Participant Teachers

Students' Learning Loss in terms of Quality of the Official Exams

Comparison of the three official exams of 2019, 2021, and 2022 was based on content covered, coverage of the three domains, and Blooms' taxonomy levels. Before the pandemic and the economic crisis, the official exams of grade 12-LS in 2019 was composed of four exercises covering the four topics required by the Lebanese curriculum: 'Human genetics; Immunology; Neurophysiology; and Regulation of female sex hormone level'. The duration was three hours, and the grade was over 20 with a coefficient of 5 to be 100. However, in 2021 and 2022 the exam was still composed of four exercises but covering only three topics out of four due to the suspensions issued by CRDP; the duration was two and a half hours, and the grade was over 20 with a coefficient of 4 to be 80.

Content Covered and Levels of Blooms' Taxonomy

The official exam of 2019 was composed of four exercises, each one covers a different topic: 'Genetics; Immunology, Neurophysiology, and Regulation of the female cycle'. However, the exam of 2021 missed the 'Immunology' topic, and 2022 exam missed the 'Neurophysiology topic'. Thus, the last two exams covered only three topics out of four because of the suspensions of CRDP.

In the 2019' exam, the exercise related to 'Genetics' addressed 'the transmission of two anomalies' compared to transmission of one anomaly in sessions of 2021 and 2022 since dihybrid cross was suspended in these two academic years. The levels of blooms taxonomy covered in this exercise were understanding and application. On the other hand, in sessions 2021 and 2022 two exercises related to genetics were asked. In 2021 exam, the

first exercise of genetics was a simple direct application of pedigree analysis that students practice in class covering the first two levels of Blooms taxonomy remembering and application. The second exercise was also direct addressing the concept of mutation and its consequences, it does not require any analysis or synthesis, also covers only the first two levels of blooms' taxonomy. In session 2022, the first exercise about genetics is similar to that of 2021, a direct application of pedigree analysis however it included one question that necessitates relating the information given to the acquired knowledge, it covered the second and third level of blooms taxonomy. The same applies on second exercise about genetics.

Related to 'Neurophysiology' the exercise in 2019 session addressed 'the action of drugs on a synapse' this topic was suspended in 2022. The students were asked to infer the mode of action of Valium thus targeting a higher level of blooms taxonomy, 'Analysis'. The neurophysiology exercise of session 2021 addressed the concept of synapse, it was a direct application targeting the first three levels of blooms taxonomy. The exercise related to 'Immunology' of session 2019 addressed 'the Immune Responses Against Flu Virus'. Students were supposed to relate new information to their acquired knowledge and covers the three levels of blooms taxonomy: Remembering; Understanding and application. Immunology was suspended in 2021. Immunology exercise in 2022 addressed a new topic related to daily life like the session of 2019. However, the questions were direct and did not reach higher levels of blooms taxonomy, it just covered remembering and understanding.

Related to the topic of 'Hormonal regulation of the female cycle' in 2019, the exercise addressed 'Hormonal Origin of a Disease'. The students were supposed to deduce the origin of hormonal troubles in a young female by validating a specific hypothesis, this exercise covered higher levels of blooms taxonomy: application, analysis, and synthesis. However, the exercises related to the same topic in sessions 2021 and 2022, were direct application of the concepts explained in class: 'Relationship between Hypothalamus, Pituitary and Ovaries', and 'Uterus and Ovarian Hormones', they covered only the first three levels of Blooms' taxonomy.

Coverage of the Three Domains

In session 2019 there is a predominance of domain B which requires reasoning, relating information, analysis, interpretation, deduction, verification... the distribution of the grades according to the three domains is represented in Table 5.

Table 5. Distribution of the Grades according to the three Domains in 2019 Exam

2019 Exam	Domain A	Domain B	Domain D	Total
Exercise 1	3.5 pts	1.5		5
Exercise 2	1.5	3.5		5
Exercise 3	1.75	1.75	1.5	5
Exercise 4	0.5	4.25		5
Total	7.25	11.25	1.5	20

On the other hand, the official exam of 2021 demonstrated a predominance of domain –A which requires direct or indirect application of acquired knowledge. The distribution of the grades according to the three domains is represented in Table 6.

Table 6. Distribution of the Grades according to the three Domains in 2021 Exam

2021 Exam	Domain A	Domain B	Domain D	Total
Exercise 1	4 pts			4
Exercise 2	2	2		4
Exercise 3	3.5	2.5		6
Exercise 4	2	2.5	1.5	6
Total	11.5	7	1.5	20

However, the exam of 2022 revealed a balance of the two domains A and B. The distribution of the grades according to the three domains is represented in Table 7.

Table 7. Distribution of the Grades according to the three Domains in 2022 Exam

2022 Exam	Domain A	Domain B	Domain D	Total
Exercise 1	3 pts	2		5
Exercise 2	4	1		5
Exercise 3	1.5	2.75	1.75	6
Exercise 4	1	3		4
Total	9.5	8.75	1.75	20

Moreover, to compute the percentages of the covered domains in the three official exams, the number of questions in each exercise covering each domain were calculated and changed into percentages, the results are presented in Table 8.

Table 8. Percentages of the Domains Covered in the three Official Exams

	Domain A	Domain B	Domain D
2019 Exam	40 %	56%	4 %
2021 Exam	55 %	40 %	5 %
2022 Exam	54.5 %	41%	4.5 %

Discussion

This study investigated secondary students' learning loss in biology from 2019 till 2022 due to the combined effect of the COVID pandemic and the economic crisis. During this period both public and private schools in Lebanon closed for long periods because of the COVID lockdown, revolution protest, and teachers' strikes. Official documents issued by CRDP were utilized to highlight the biology content suspended during this period. On the other hand, a questionnaire was elaborated by the researcher to investigate students' learning loss in

biology based on teachers' experience. In addition, the quality of the three official exams of 2019, 2021 and 2022 was assessed based on specific criteria.

To answer the first question of research about students' learning loss in biology in terms of content: the comparison of the three official documents issued by CRDP concerning the biology content required and suspended showed an enormous knowledge gap in biology in grades 10, 11-S and 12-LS. This aligns with the study of Ndeda and Smith (2021), which emphasized that Lebanese students need catchup classes between 6 and 8 weeks in the academic year 2020-2021. Around 50 % of the biology curriculum was suspended by CRDP for G10, G 11-S, and G 12-LS during the academic years 2020-2021 and 2022.

In G 10 half of the Biology program was suspended in 2020-2021 and around 25 % in 2021-2022, compared to 2018-2019. The main topics suspended in G10 during the academic years of 2020-2021 and 2021-2022 are: "the Influence of Light and Carbon Dioxide on the Intensity of Photosynthesis"; "Evaluation of Running Water Pollution"; "Precipitation and Infiltration"; "Reducing Agricultural Pollutants". All of these are essential topics for students to understand how to protect the environment and reduce pollution (CRDP, 2019).

In G 11-S, half of the biology program was suspended from 2020 till 2022, the main topics and lessons suspended include: "Enzymes as biological catalysts, and reaction rate and optimum conditions"; "Nature of metabolites"; "The muscle fiber and its metabolism"; "The restoration of ATP"; The whole chapter of "Diversity of feeding habits"; The whole chapter about "Nutritional Diseases"; The whole chapter about "Energy of the Cell Functioning". Knowing that these topics are essential for awareness during this age, and some are prerequisites for topics required in G12 (CRDP, 2019).

Similarly, in G 12-LS where students should pass the official exams to be able to join university, CRDP suspended 58 % of the biology program required for the official exams in 2021 and 46 % in 2022 compared to the requirements before the pandemic and the economic crisis. For the first time G 12 students were officially assessed with reduced curriculum-content on one hand and reduced curriculum-subject on the other hand. 2021 exam excluded the "Immunology" topic and 2022 exam excluded the "Neurophysiology" topic. In 2021-2022 few lessons were reintroduced compared to the previous years, however, the unexpected school closure because of the economic crisis prevented students in both public and private schools from attending their classes leading to more learning loss. This is in agreement with the study of Hammoud et al. (2021) which emphasized that the economic crisis has added to the workloads of schools, teachers, and parents, and it has increased the likelihood that students would not receive proper education.

To answer the second question of research concerning students' learning loss from the perspective of teachers: the analysis of the data collected from the teachers' questionnaire revealed also a huge learning gap in the biology program. In 2019-2020, 64 % of participant teachers covered 50 % and less of the biology program in G10; 57.4% of the participants covered 50 % or less in 2020-2021; and 51% of the participants in 2021-2022. Similar results were obtained for G11-S, in 2019-2020 50 % and less of the biology program was covered according to 66 % of teachers; in 2020-2021, 57.4% of the participants covered 50 % or less; and in 2021-2022,

55% of the participants covered 50 % or less of the program. However, the results related to G12-LS revealed that in 2019-2020 50 % and less of the biology program was covered according to 42 % of participant teachers; in 2020-2021, 45 % of the participants answered that 50 % or less of the program was covered; and in 2021-2022, 36 % of the participants answered that 50 % or less of the program was covered. Moreover, the results of the teachers' questionnaire revealed that there is an association between type of school and the content covered, in grades 10, 11S, and 12LS, in 2020-2021; for all the studied academic years in G 10; and in 2021-2022 for G 11-S. More content was covered by teachers in private schools. These results line up with the study of Hammoud and Shuayb (2021), which revealed that the number of instructional days varied between public and private school, in favor of private ones. Discrepancies between public and private schools was also highlighted by the study of Frayha (2009). Thus the time of school closure might have affected the content covered and consequently students' learning, with To answer the third question of research concerning students' learning loss in terms of quality of official exams: the data revealed a decline in the quality of the official exams. The comparison of the official exams in 2021 and 2022 to the exam of 2019 (before the dual crisis) showed that the content covered in these two exams is less, three topics out of four because of curriculum suspension. There is less emphasis on the reasoning domain (Domain B) specifically in session 2021, more emphasis on questions that requires mastering of acquired knowledge (Domian A). Moreover, the questions in sessions 2021 and 2022 were simpler compared to 2019 and they covered only the first three levels of Blooms' taxonomy: remembering, understanding, and applying.

Conclusion

This research investigated Lebanese secondary students' learning loss in biology in the period between 2019 and 2022, based on three constructs: curriculum content, teachers' experience and standardized assessment-the official exams of G12. The dual economic and COVID crisis that stroked Lebanon during this period lead to school closure for extended period of time for three consecutive academic years, the MEHE in collaboration with CRDP reduced the curriculum and the content required for the official exams. The data collected in this study revealed that Lebanese secondary students experienced a huge learning loss in biology during the studied period. In 2019 both public and private schools in Lebanon closed for several months because of the COVID lockdown and the economic crisis, and irregular online classes were given. However, 65 % of the participants that filled the questionnaire agreed that students did not have an equal chance to follow online classes, and 52% of then were able to cover the required content. According to Rouadi and Anouti (2020), the experience of online learning was unsuccessful in Lebanon mainly due electricity cutoffs, unstable and weak internet connection, and lack of students' participation. Similarly, according to Hammoud and Shuayb (2021), the quality of education declined after adapting distance learning during COVID-19 lockdown, mainly due to the overall reduction in the number of teaching days and hours, due to the teachers' week experience in distance learning, students in Lebanon have a "lost year" of education. The results are in congruence with the study of CRDP (2021) which revealed that many obstacles influenced the curriculum achievement during online learning. Moreover, the analysis of the official documents issued by CRDP concerning the topics and lessons suspended in the academic years of 2020-2021 and 2021-2022, and based participant teachers' experience, more than 50 % of the biology program was not covered in grades 10, 11-S and 12-LS. Similar results were obtained

by study performed by CRDP (2022) which investigated the extent to which the main objectives and the main topics in the Lebanese curriculum were achieved during the academic year 2020-2021. The study showed that 65 % of the program was achieved despite all difficulties. Our results align with the declaration of the Ministry of Education and Higher Education (MEHE) in the Circular No. 39/m/2022 on 13/10/2022, which highlighted Lebanese students' learning loss at the level of knowledge and skills due to the curriculum reduction because of Corona pandemic and the economic crisis, and emphasized the necessity to go back gradually to the curriculum before the reductions. Finally, the study raises an alarm about quality of education in Lebanon, which is declining according to the World Bank (2021).

Recommendations

The Lebanese Ministry of Education should take into consideration students' learning loss due to extended school closure and curriculum suspension because of the pandemic and the economic crisis. Serious steps should be taken to compensate students' knowledge gap, catch up classes and resources can be adapted. Teachers should follow certain strategies and assessment methods that enable them to diagnose students' learning loss and aid them to acquire the basic knowledge and skills essential for the class that they are enrolled in. Moreover, the recommendation outline of the comprehensive reform of education in Lebanon provided by the World bank report entitled: "Foundations for Building Forward Better: An Education Reform Path for Lebanon" (World Bank, 2021), should be taken into consideration by stakeholders, policy makers, MEHE, and CRDP. The report provides a summary of the major issues the education sector is experiencing, it offers evidence-based remedies built on an analysis of the causes of the learning crisis and makes recommendations for policy reform over the short-, medium-, and long-terms. Finally, future studies should address learning loss from the perspective of students and stakeholders. Learning loss in other grades and other subjects can be investigated in further researches.

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