Knowledge and perception of middle school students regarding COVID-19 disease at the start of the pandemic

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Abstract
Facing recent threats of coronavirus disease (COVID-19), an educational strategy was designed and applied to middle school students in order to reinforce related knowledge and behaviors. A group of 65 middle school students (14–18 years old) developed several designed online curricular activities. After the intervention, students answered a questionnaire to assess if they: (a) were familiar with the terms COVID 19 and SARS-CoV-2; (b) were conscious about the importance of preventive measures to stop the spread of this disease; (c) were engaged in these activities; (d) were motivated to research on health-related issues. This study was a first to attempt to evaluate student’s perceptions about SARS-CoV-2 infection and support education regarding COVID-19, mainly on the reinforcement of preventive measures.

KEYWORDS
COVID19, e@d, knowledge attitudes/practices on COVID 19, middle school level, SARS-CoV-2

1 | INTRODUCTION

The year 2020 was contemplated by an infection with a virus from the Coronaviridae family, termed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes the coronavirus disease 2019 (COVID-19). After being reported in Wuhan, China¹, COVID-19 readily spread to more than 150 countries, and the World Health Organization² recognized it as a pandemic. For the first time, human confinement was global and all the human activities stopped.

COVID-19 was reported to be initially transmitted from animals to humans, but then acquired efficient human to human spread in a rapid way.³ Thus, there was an urgent need to reinforce preventive and control strategies for minimizing the rapid spread of this infection across the globe.⁴ A fundamental issue to face the COVID-19 crisis was the need to act fast and answer to the changing circumstances, such as variations in the state of public health knowledge and political/economic situation.⁵ Public health and emergency management agencies are on the front line of informing and educating the public about infectious disease transmission and prevention measures.⁶ One of the most effective means of directly reaching the public is through the use of digital/social media.⁷

In this scenario, citizens must be alert and informed to understand the messages conveyed by the social media and the news. Here, the school has a mission to developed scientific literacy that allows students, future citizens, to understand those messages and distinguish sources of information and their content, avoiding the proliferation of fake news and alarmism’s.

In Portugal, COVID-19 officially spread on March 2, 2020.⁸ On March 13, all the Portuguese schools were closed and distance learning was implemented during the remaining school year.⁹ This fact forced a new and unexpected learning experience. On March 18, the President of the Portuguese Republic, declared the “State of Emergency”.¹⁰ Several changes were then introduced to
teaching, bringing new challenges for teachers, students and families, that had to adapt to the new remote-learning life. The instructional activities must be outfitted for distance learning, but they must also ensure that students still have opportunities for being engaged in inquiry activities, develop epistemic practices and increase their scientific literacy. Epistemic practices can be defined as social activities of production, communication and evaluation of knowledge, which require the knowledge and experience of others, in order to learn to deal with uncertainty, articulate ideas in public forums, make use of evidence, take into account the ethical conclusions from their investigations, reaching consensus and making decisions.11

Taking into consideration the need to increase student's scientific literacy in order to allow them to move in the middle of huge amount of information circulating in newspapers, television and social networks, it was important to design curricular activities, delivered remotely, that still allow them to develop important epistemic practices (e.g., research and select information, organize information, identify patterns, questioning, make predictions, communicate, and validate knowledge). Given the fact that we were facing a new disease, students' lack of knowledge was a reality and some misconceptions were being constructed. This was the moment to address students' needs and design a curricular approach contextualized by the current moment and its challenges. Previous studies revealed that the interest of students on health subjects can increase significantly if teachers are involved and when appropriate methodologies are used.12

Taking that into account the above described issues, an educational strategy was designed and applied to 9th grade students in order to reinforce the knowledge and behaviors adopted on the management of COVID-19. Through remote-learning, that in Portugal was called E@D, it was proposed that 65 Portuguese middle school students (14–18 years old) developed several activities to help increase their knowledge about this disease.

The objectives of this study were: (a) to promote health awareness; (b) to evaluate the efficacy of the school intervention in improving students' knowledge on COVID-19: (b1) to know transmission vehicles of SARS-CoV-2; (b2) to increase knowledge on prevention measures of COVID-19; (b3) to recognize COVID-19 symptoms; (b4) to know risk factors to contract COVID-19; (b5) to know how the spread of infection by the new coronavirus can be slowed down; (b6) to encourage students' research.

This study describes an unpretentious and easily implemented activity available to 9th grade students (14–18 years old), that allows them to develop several important competences such as to read scientific information, identify reliable sources of information, select information to produce a report, write a scientific report based on literature review and communicate the knowledge produced. However, this activity also allowed us to infer on the knowledge about COVID-19 acquired by the students subjected to this kind of activities.

2 | MATERIAL AND METHODS

2.1 | Teaching activity

During remote teaching and learning, the Natural Sciences teachers challenged their students with a task. The task was about searching for information on several bibliographic sources, websites, online newspapers, science journals, or institutional websites. Students worked collaboratively, divided in teams of five students, which selected relevant reliable bibliographic sources with information on COVID-19 symptoms, transmission vehicles of SARS-CoV-2, prevention measures, risk factors, and spread of infection. Students were asked to prepare a list of criteria that allows them to select the most reliable bibliographic sources. This list was discussed by students and teachers. After assessing the references found, each group of students presented the selected list of references to the teacher. After this discussion, students used the information, identified relevant facts, recognized patterns and produced their report almost like a literature review paper. The collaboration among students was developed with collaborative tools and the results were presented and discussed with the colleagues, during synchronous remote sessions. This curricular intervention took 3 weeks. In the first week, students identified the bibliographic sources; in the second, students discussed their reference list with the teacher, presenting their assessment and validation criteria (negotiated with the teacher) and prepared their reports; in the third week, students presented and discussed their reports with their colleagues and teacher. During this period of time, students worked in straight collaboration with the teacher, that provided frequent feedback and scaffold their work using technological apps and tools (e.g., E-mail, Google Classroom, Google Meet, and Google Docs). The teacher acted less as an activity instructor, but more as facilitator of students' learning, ensuring their engagement with technological tools that allow remote teaching and scaffolding the students work, providing insights, and support when needed.

The student's knowledge about COVID-19 disease was evaluated by application of a questionnaire (Appendix 1) to all students from the school: students
that performed the described activities and a control group (9th grade students, 14–18 years old) who did not carry out the activity and are from different teachers that were not involved in this intervention.

2.2 | Research questions

The specific research questions addressed in this school activity were: to what extent (a) do the students have an adequate knowledge about COVID-19 and SARS-CoV-2? (b) are students aware of the risk factors for COVID-19 and preventive measures to slow down spreading? (c) did the school intervention change students’ knowledge and perceptions of the students on COVID-19? (d) did the implemented activities motivate students?

2.3 | Population and sampling

A convenience sample of middle-school students was used in this activity. Information about possible confounders, such as socio-economic status and intellectual level, was not collected. This activity was developed between April and June 2020. This study involved students from a public middle-school from Portugal. The sample comprised 154 students from 9th grade (14–18 years old), 65 students belonging to the study group and 89 to the control group.

This activity was approved by the School Board, after online hearing the Pedagogical Council because there is no ethics committee at the School. Student’s participation was voluntary.

Informed consent was obtained verbally from the students’s guardians on behalf of the students enrolled. This consent was obtained during an online meeting, in which the School Director explained the aims of this study and requested authorization from the guardians.

All the data used in this study were anonymized. Part of the study involves collaborative work.

2.4 | Data collection and analysis

The quantitative results of this study were obtained through the application of an online questionnaire in the 3th academic period (May) in which teaching in Portugal took place online (E@D). We measured the questionnaire validity by means of a pilot study with 10 students from the same scholar level. The questionnaire was revised based on the recommendations of these students prior to administration. The questionnaire contained 12 questions covering several topics concerning COVID-19 (Appendix 1). Questions were constructed by the authors involved in this study.

2.5 | Data analysis

Data obtained in the study group and control group were analyzed using GraphPad Prism 9. Associations between variables were tested with Chi-square (and Fischer’s exact test) with significance set at the \( p < 0.05 \) level.

3 | RESULTS

3.1 | Performance of the students in the questionnaire

3.1.1 | General questions (questions 1, 10)

In question 1 (Q1), the data collected showed that 92% of the participants knew that bacteria have everything they need to live, whereas virus only multiply inside a host. However, all the students of the control group also answered adequately (\( p = 0.0068 \)) (Figure 1).

Regarding question 10 (Q10), related to the difference between an epidemic and a pandemic, 95% of the students from the study group responded adequately and all the students from the control group answered adequately, with no significant differences detected (\( p = 0.0594 \)) (Figure 1).

3.1.2 | Specific questions related to COVID19 disease (questions 2–9, 11, and 12)

Data presented in Table 1 and Figure 2 show the knowledge of students on COVID-19 disease (Q2). About 97%
### Table 1: Student responses to questions 2-9, 11, and 12

| Questions                                                                 | Adequate answers (%) | Incomplete answers (%) | Inadequate answers (%) |
|---------------------------------------------------------------------------|----------------------|------------------------|------------------------|
|                                                                           | Study group          | Control group          | Study group            | Control group          |
| Q2. What is COVID-19?                                                    | 97                   | 99                     | 3                      | 0                      |
| Q3. What is your perception on COVID-19 aggressiveness?                  | 26 (very dangerous)  | 74                     | -                      | -                      |
|                                                                            | 74 (moderately dangerous) | 26 (moderately dangerous) | 45                     | 29 (not very dangerous) |                     |
|                                                                            | p = 0.6212           |                        | -                      | -                      |
| Q4. Which type of agent is SARS-COV-2?                                   | 26 (digestive and   | 24 (digestive and     | 71 (respiratory        | 76 (respiratory        |
|                                                                            | respiratory infections) | respiratory infections) | infections)            | infections)            |
|                                                                            | p > 0.05             |                        | -                      | -                      |
| Q5. Which symptoms are associated with COVID-19?                         | 100                  | 100                    | 0                      | 0                      |
| Q6. What is the contagion period of COVID-19?                            | 99                   | 99                     | 1                      | 1                      |
| Q7. How does SARS-COV-2 infection transmission occur?                    | 99                   | 99                     | 1                      | 1                      |
| Q8. What is COVID-19 infection rate?                                     | 34                   | 15                     | 66                     | 85                     |
| Q9. Which are the risk groups for COVID-19 infection?                    | 89                   | 0                      | 11                     | 100                    |
| Q11. How can the spread of infection be slowed down?                     | 95                   | 100                    | 5                      | 0                      |
| Q12. Which are the factors that can protect against SARS-COV-2           | 12                   | 19                     | 88                     | 81                     |
|                                                                            | transmission?        |                        |                        |                        |
of the students knew what is COVID-19 and there no significant differences between the study and control group ($p = 0.6212$).

Regarding the perception of COVID-19 danger (Q3), 26% of the students classified this disease as very dangerous and 74% moderately dangerous, however, in the control group 26% of the students consider the disease very dangerous, 45% moderately dangerous and 29% not very dangerous (Table 1, $p > 0.05$).

In question 4 (Q4), only 26% of the students associated this disease to human infections in the respiratory and digestive systems, however 71% associated COVID-19 to respiratory infections (Table 1). In the control group, 24% of the students associated this disease to digestive and respiratory infections (Table 1). No significant differences were detected ($p > 0.05$).

Concerning the symptoms associated with the new coronavirus infection (Q5) and to the contagion period (Q6), 100% and 99% of the students of the study group, respectively, answered adequately (Table 1 and Figure 2). The results of the control group were similar; $p$ values are, respectively, 0.999.

In respect to COVID-19 infection rate (average) (Q8), 34% of the students from the study group answered adequately (1.5), 15% (5.0), 15% (2.2), 23% (3.0), and 11% (0.5) and 2% did not answer (Table 1 and Figure 2). For the control group, 15% of the students answered adequately (Table 1 and Figure 2). Significant differences were detected between the study and control group for this question ($p = 0.0028$).

In respect to the COVID19 risk groups (Q9), 89% of students of the study group referred elderly, diabetics and autoimmune diseases, 3% indicated only diabetics and 8% people with autoimmune diseases (Table 1). In the control group none of the students answered adequately (Table 1 and Figure 2) $p < 0.0001$.

Regarding the transmission of the new coronavirus (Q7), 99% of the study group and 99% of the students of control group answer adequately ($p = 0.999$). In respect of decrease in the spread of infection (Q11), 95% and 100% of the study and control group answer adequately ($p = 0.0059$). Concerning the protection against coronavirus transmission/reduction of risk infection, only 12% of the study group and 19% of the control group checked all the adequate options (Q12) ($p = 0.0594$).

## DISCUSSION

SARS CoV-2 infection took the world to a standstill; however, there are still many questions unanswered, such as on the origin and the primary route of transmission. Numerous countries, including Portugal, have gone in to a complete lock-down to limit the spread of this infection. In this context, education became threatened due to the mass closure of schools and implementation of remote classes (E@D), which were not easily accessed by every student.

Our study intended to increase the awareness and assess the knowledge and perception of Portuguese students from 9th grade (14–18 years old) on COVID19 disease. This study is of great importance since it targets younger people who represent a significant percentage of the Portuguese population and because students of this age are often asymptomatic and can transmit the disease. Zou and co-workers found that asymptomatic individuals secrete comparable viral load relatively to symptomatic patients. This point is dangerous since the transmission capacity of minimally symptomatic or asymptomatic COVID-19 patients is very high and equally comparable to symptomatic patients, indicating that the transmission can occur early in the course of infection.

Between March and June 2020, students are at home and classes were delivered online through remote learning (E@D). Thus, through E@D, was proposed to 9th grade students (14–18 years old) to investigate and search for information about COVID-19 and write a small report in a team. This work was followed by the application of a questionnaire (Appendix 1). Teachers' perceptions were that students involved were interested in health issues and the implemented activity motivated these students very much.

The results of this study showed that students in this period acquired significant knowledge relatively to the virus and symptoms associated, contagion period, transmission, risk groups, and spread of the infection. Nevertheless, lack of knowledge was noted regarding infection rate (Q8), values of adequate answers were 34% and 15%, respectively, for study and control group ($p = 0.0028$), and behaviors regarding protection from coronavirus infection (Q12) since the values of adequate answers...
were 12% and 19%, respectively, for the study and control group, with no significant differences detected between study and control group ($p = 0.0594$). Only 31% of the study students checked that is important to use appropriate masks, only 9% referred the importance of washing hands properly and frequently, only 2% referred the importance of use protective fabrics, only 6% referred avoid contact with infected people and avoid touching the nose, mouth and eyes, only 9% think that is important to avoid spaces with many people and only 2% think that public transports should be avoided (Q12). The results of the control group were quite similar.

According to other studies, several preventive measures must be adopted to stop this infectious disease such as increasing personal hygiene measures as frequent hand washing, respiratory etiquette, cleaning and disinfecting surfaces, social distancing, and care when dealing with infected individuals.

In Hong Kong, some personal behaviors were suggested to be effective to control pandemics such as SARS and H5N1. Preceding researchers suggested that visiting public places and the places having confirmed cases were risk factors, while frequent mask use hand washing and disinfection, were protective measures. Other studies propose that individuals should take preventive measures, such as frequent hand washing, staying at home when they are sick and coughing and sneezing.

The results obtained in this study revealed that for the majority of the questions no significant differences were observed between the study and control group, except for questions 1, 8, and 9. Results from Q8 and Q9 were predictable, since some students focus their reports on the information about the main risk groups, such as old people, diabetics and people with autoimmune diseases and likewise addressed well the problem of infection rate. According to the literature, this infection may lead to severe symptoms in people with a weak immune system, older people, and individuals suffering from diabetes, cancer, and chronic lung diseases.

The results obtained in the remaining questions were quite similar. In our point of view, these results can be explained based on the crucial role that the media and social networks had in this period. Between March and June, the Portuguese Ministry of Health and General Directorate of Health (DGS) held daily press conferences transmitted on the national TV with information on the state of the pandemic, the virus and recommendations on preventive measures to be taken to fight the spread of COVID-19 disease (Portuguese Television: SIC news, RTP1, RTP3, and TVI). Furthermore, the media and social networks broadcasted innumerable informative/educational programs, videos, podcasts, testimonies and posts in order to inform the population about the status of the disease such as: ways of propagation, protective measures, associated symptoms, risk groups, contagion period (e.g., “COVID-19: Fighting a Pandemic”, “Un salón, un bar y una: así contagia el coronavirus en el aire”, “Five coronavirus mysteries scientists are still racing to solve”, “The importance of social distance” – Facebook post Paulo Edson Cunha). Additionally, DGS initiated educational campaigns placing posters in public buildings and published every day a COVID-19 Situation Report, however the sources of information most often used by young people are Facebook, WhatsApp, and TV, with the associated accuracy problems.

These results are in agreement with other studies regarding Middle East Respiratory Syndrome (MERS) epidemic in Saudi Arabia. This study suggests a good relationship between information available in the media about MERS and the depth of students’ knowledge. Relatively to MERS-CoV infection, Al-Hazmi and coworkers revealed that more emphasis should be placed on educating the students about preventive measures such as using paper tissues when sneezing and coughing and proper tissue disposal.

The results of our study group revealed that 26% of the students consider the disease very dangerous and 74% moderately dangerous (Q3), however in the control group 45% of the students consider the disease moderately dangerous and 29% not very dangerous ($p > 0.05$). This result could be explained by the fact that in the study group the Sciences’ teacher repeatedly drew students’ attention to the severity of the disease.

## 5 | CONCLUSIONS

Our study was a first to attempt to measure the perceptions of students about SARS-CoV-2 infection (COVID19). Students’ education support regarding COVID-19 should continue, mainly on the reinforcement of the preventive measures, such as vaccination. It is important to encourage and safeguard the specific role of students in breaking transmission chains, contributing decisively to the protection of their community.

This was an effort to address an eminent health and educational challenge, and was possible to deliver contextualized activities that help to increase students’ knowledge on the subject. Also, this educational intervention highlights that even through remote teaching and learning is still possible and effective to develop inquiry activities and engage students in important epistemic practices.

As future work it will be important to reinforce the knowledge on the role of vaccines in order to stop the transmission channels of this disease. Also, vaccination is
a crucial topic that requires recognition of its importance and school must also work for the development of scientific literacy in this domain.

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APPENDIX: 1—Questionnaire

Questionnaire developed by the authors and validated by independent researchers from Health Science Researchers.

1. Regarding bacteria and virus multiplication:
   a. Bacteria have everything they need to live, whereas virus only multiply inside a host.
   b. Bacteria and virus multiply only inside a host.
   c. Bacteria multiply only inside a host, whereas virus have everything they need to live.
   d. Bacteria and virus do not have DNA.

(Check the correct option)
2. COVID-19 is:

a. The name of the disease caused by the SARS-COV-2 virus.
b. The name of the disease caused by the flu virus.
c. The name of the disease caused by the HIV virus.
d. The name of the disease caused by the HPV virus.
e. All previous statements.

(Check the correct option)

3. Regarding the aggressiveness of COVID-19, indicate your perception of the disease in healthy individuals:

a. Very dangerous.
b. Moderately dangerous.
c. Not very dangerous.

(Select only one option)

4. A coronavirus is:

a. A pathogenic bacterium.
b. A group of viruses that can cause infections in the human respiratory system.
c. A group of viruses that can cause infections in the human digestive system.
d. A bacterium that lives in symbiosis with man.
e. Statements b and c are correct.

(Check the correct option)

5. The symptoms associated with the new coronavirus infection are:

a. Fever (temperature $\geq 38.0^\circ$C).
b. Cough.
c. Breathing difficulty.
d. Sore throat and headache.
e. All of the previous options.

(Check the correct option)

6. The contagion period for the new coronavirus (time between exposure to the virus and the onset of symptoms) is approximately:

a. 2 days.
b. 5 days.
c. 10 days.
d. 14 days.
e. 20 days.

(Check the correct option)

7. The transmission of the coronavirus occurs through:

a. Dissemination of respiratory droplets when an infected person coughs, sneezes or speaks.
b. Inhalation or through the mouth, nose or eyes of people who are close (<2 m).
c. The contact of the hands with a surface or object contaminated with the virus, which then contact the mouth, nose or eyes.
d. All of the above.

(Check the correct option)

8. The COVID-19 infection rate is on average:

a. 1.5
b. 5.0
c. 2.2
d. 3.0
e. 0.5

(Check the correct option)

9. Regarding the contraction of this disease, the risk groups are:

a. Elderly people
b. Diabetics
c. People with autoimmune diseases
d. Babies
e. People with hypertension

(Check all the correct options)

10. What is the difference between an epidemic and a pandemic?

a. An epidemic is when a disease occurs with an unusual frequency in a given region and for a limited period; a pandemic is an epidemic that spreads at the same time in several countries.
b. An epidemic is a disease that spreads at the same time in several countries; a pandemic is when a disease occurs with unusual frequency in a given region and for a limited period.
c. An epidemic is a chronic disease; a pandemic is an acute disease.
d. An epidemic is an acute illness; a pandemic is a chronic illness.
e. An epidemic is a disease caused by bacteria; a pandemic is a disease caused by a virus.

(Check the correct option)
11. How can the spread of infection by the new coronavirus be slowed down?

a. Taking antibiotics.
b. Taking antivirals.
c. Social distance.
d. Injecting disinfectant into the body.
e. All previous statements.

(Check the correct option)

12. Select all the correct options that protect against coronavirus transmission and reduce the risk of infection:

a. Use of an appropriate mask.
b. Wash your hands properly and frequently.
c. Use protective fabrics.
d. Avoid contact with infected people.
e. Avoid touching the nose, mouth, and eyes.
f. Avoid public spaces with many people.
g. Avoid using public transport.