Title: Teaching and classroom communication with children in the COVID-19 pandemic

Running title: Teaching and communication in pandemic

Author's names: María I. Tapia^a, Jesús A. G. Ochoa de Alda^{a,*}, Jin Su Jeong^a and David González-Gómez^a

Affiliations: ^aDepartamento de Didáctica de las Ciencias Experimentales y Matemáticas, Universidad de Extremadura, Avd. de la Universidad s/n, 10004, Cáceres, Spain

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Abstract

Prioritizing communication with children about the disease is an essential component in the fight against the COVID-19 pandemic. Talking to children at school about the pandemic enables them to understand what is happening. This improves their motivation to cooperate and their adherence to protective behaviors and helps them feel less frightened and distressed. Therefore, it is urgent to develop evidence-based but child-focused communication guidelines. In the absence of this resource to support teachers, this contribution address three main points: i) how to communicate pandemic aspects to their students; ii) how to integrate knowledge about COVID-19 and other aspects of this pandemic in science curricula; iii) how this knowledge is useful to protect themselves and their students. To improve communication, teachers must be aware of children's and adolescents' cognitive, emotional, and psychological development. According to this development, simplifying language and concepts ensures that communication provides comprehension of illness and its causality. This contribution allows teachers to frame COVID-19-related content into each curriculum level, tackling misconceptions and providing reliable information. The fight against COVID-19 exemplifies dynamic aspects of science and engineering in the real world, an opportunity to strengthen the interactions between different disciplines in science lessons. Embedding the basic science of COVID-19 into curricula will allow students to understand how to protect themselves and others. The connection of course materials to students' lives will increase student motivation and learning. Education can empower children to advocate for their participation in the containment of the pandemic.

Keywords: Schools; Curriculum; Child; Communication; Learning; COVID-19.

Introduction

Coronavirus disease 2019 (COVID-19) is spreading very quickly worldwide, having a significant impact on 89% of the world's student population. World attention focuses on measures to mitigate the transmission and the pandemic's social and economic effects. The outbreak entirely dominates media and social conversations.

An important but easily neglected issue is the impact on children's psychological well-being and lives (Sharfstein & Morpew, 2020). During this pandemic, children are experiencing substantial and sudden changes in their daily routine and social infrastructure. Virtual instruction replaces face-to-face teaching, at best (Donohue & Miller, 2020; UNESCO, 2020). Children are exposed continuously to epidemic-related news. Even two-year-olds are aware of the changes around them (Dalton, Rapa, & Stein, 2020), including their parents' angst. Exposure to unexplained and unpredictable behavior is perceived by children as a threat, resulting in a state of anxiety (Dalton et al., 2020). Children can feel intense emotions, such as fear, sadness, anger, guilt, and feelings of vulnerability and lack of control. These stressors may vary throughout the days and can have adverse and enduring effects. The impact, depending on each children's circumstances, is different. Youngest children possess limited emotion regulation strategies. Their ability to express feelings is not fully developed, limiting emotion regulation through verbalization (Dunn, Bretherton, & Munn, 1987).

Childhood is when children interact with their surrounding world to progress towards their understanding while dealing with reality. Children learn about their emotional needs (the extent to which something is "good" or "bad" for them) according to their intellectual constructions (Sherry Turkle, 2008), most of them developed in educational settings.

Good knowledge of the students of what the pandemic entails is crucial since it could alleviate their fears and anxiety. Children need honest information about this pandemic; when this information is absent, they attempt to make sense of the situation on their own (Christ & Christ, 2006). To this end, schools are critical since they offer students an opportunity to interact with teachers and obtain counseling. Teachers are well placed in their community to work with children. They can identify ways to address problems. They know what knowledge and rumors are circulating, and they can efficiently communicate with students.

Teachers should ensure that the information communicated is meaningful to enhance students' sense that they understand the world; this will induce positive feelings, such as satisfaction, fostering their interest in learning more (Sharot & Sunstein, 2020). Besides, talking to children about the pandemic enables them to understand what is happening and improves their motivation to cooperate (West, Michie, Rubin, & Amlôt, 2020).

A pandemic related topic is an opportunity to strengthen the interactions between different disciplines in science lessons. Teachers can frame COVID-19-related content into the curricula, tackling noncanonical ideas students express in science (misconceptions), and providing reliable information. They could explain some of these contents grounded on basic science for each educational level. The combination of rigorous content and its application reflects how the real-world practices science and engineering. The connection of course materials to students' lives will increase student motivation and learning (Hulleman & Harackiewicz, 2009).

Effective communication requires a previous theoretical and practical training of the teacher, who must have first-hand access to quality information. This access to reliable information is critical to counteract misinformation (false and harmful content) and disinformation (biased information and propaganda) since there has been an

uncontrolled spread of fake news “rumors” to which children are particularly vulnerable (Caulfield, 2020).

In the absence of evidence-based education guidelines to support teachers to deal with this new illness, we aimed to address here: i) how to communicate pandemic aspects to their students; ii) how to integrate knowledge about COVID-19 and other aspects of this pandemic in science curricula; iii) how this knowledge is useful to protect themselves and their students

How to communicate with children about the COVID-19 pandemic

In seeking to improve communication, teachers must be aware of children’s and adolescents’ cognitive, emotional, and psychological development to ensure that communication is effective, and neither underestimates nor overestimates their understanding (Stein et al., 2019). Communicating with younger children relies on their comprehension of illness and causality by simplifying the language or concepts.

Children’s understanding of illness evolves from a few concrete, clearly defined subcomponents to more complex and abstract components gradually acquired (Stein et al., 2019). Between 4 and 7 years old, children’s understanding of what causes illness is substantially influenced by what is known as magical thinking (Eiser, 1989), children’s belief that thoughts, events, or wishes can cause external events (e.g., a particular thought or behavior causes illness). Concurrently children have an emerging sense of conscience, but a poor understanding of how the disease spreads; this can easily lead to misattribution of cause and consequent guilt (e.g., illness is a punishment for their poor behavior) (Schonfeld, 1993). “These concepts highlight the importance of ensuring that the language used with children is concrete and specific to avoid misunderstanding or incorrect inferences about the cause of illness” (Stein et al., 2019). Games to learn about

safe distances, mask use, the importance of ventilation, and healthy habits should be adequate. Classroom and personal rules can support these games (West et al., 2020), such as coughing or sneezing into disposable tissues or wearing fitted masks.

Between the ages of 7 and 11, it takes place a significant shift in children's understanding of fundamental biological concepts about living beings' characteristics, the structure and function of the human body, and disease transmission. They can understand disease changes if they are tangible and observable since they use their emerging reasoning skills to integrate concrete rather than abstract concepts or invisible things inside the body (Eiser, 1989). However, they may find it more challenging to achieve a fuller understanding of the disease (Stein et al., 2019)..

After the age of 10-11 years, adolescents' focus on short-term consequences is particularly relevant (Stein et al., 2019). For adolescents of any age, the uncertainty and the loss of their freedom will be hard to process and could lead to long-term behavioral problems. Tension is created between the different priorities of adolescents' desire for independence and the measures taken to contain the pandemic (Essig, Steiner, Kuehni, Weber, & Kiss, 2016). Adolescence also involves establishing autonomy from parents or caregivers, which might conflict with periods of increased restrictions. There is a substantial increase in peers' salience and influence; establishing and maintaining peer group identification is complicated by social isolation (Stein et al., 2019).. Personal and trustful relationships, together with empathy, respect, and professional competence, can help teachers to communicate effectively during the last years of Primary Education. Being able to negotiate with students is also helpful, as is taking an interest in its world. Classroom messages or debates should focus on the need (rather than on the obligation) of protective behaviors, whereas recognizing the balance of different priorities and inhibitions at critical moments. Students need to perceive that the benefits of protective

actions outweigh the costs (giving support if required to mitigate the cost). Exemplify habits that come into play when needed (Stein et al., 2019; West et al., 2020).

Culture and traditions, ethnicity, religious and spiritual beliefs will also influence children's and parents' perspectives. Teachers should avoid misunderstanding and stereotypes and recognize the different cultural and religious reference points of family members. Respect is the general rule (Stein et al., 2019).

Teachers can use technical or factual language to try and minimize their children's distress. However, it is not enough. Children's emotional needs cannot be neglected during conversations since they might leave children anxious about the adults' emotional state around them. Teachers (and parents) need to be authentic regarding the pandemic's uncertainty and psychological challenges, without overwhelming children with their fears. This communication strategy offers children a coherent explanation of what they observe and allows them to regulate emotions by permitting children to talk about their feelings safely (Dalton et al., 2020). Teachers should have the ability to recognize and respond to children's cues of distress sensitively. It is essential to listen to their beliefs about COVID-19 transmission to cope with the stress (Dalton et al., 2020). Teacher support should recognize disease transmission concerns to motivate protective actions rather than anxiety. The latter could lead to defensive avoidance (West et al., 2020), such as reducing social relationships or school attendance.

How to integrate knowledge about COVID-19 and other aspects of this pandemic in science curricula

Existing primary school curricula allow the integration of age-responsive activities and content about this topic. In most curricula, children now have to study Experimental Science to develop fundamental scientific ideas and understand the world's nature,

highlighting the interplay of science, technology, and society. This content block usually includes studying life processes and living things, materials and their properties, and physical processes. We outline how to integrate current scientific knowledge about COVID-19 and other aspects of this pandemic into children's preexisting education, daily activities, and lessons.

Role of science and science communication

1. The power of science

The most notable difference between the COVID-19 worldwide spread and all previous pandemics is current science's power. Humanity is now much better equipped than before to face any epidemic: i) researchers have rapidly identified and characterized the infectious agent SARS-CoV-2; ii) high-security microbiology laboratories are available; iii) the pharma-biotech industry is developing several vaccine candidates; iv) disease transmission is better understood. Teachers should acknowledge and maximize that. It could be helpful to get children to think about past pandemics. Teachers can make children imagine what it would be like to live through the 1918 flu pandemic that killed at least 50,000,000 people worldwide. That virus was no worse than this one, SARS-CoV-2, and may not even have been as deadly by itself. The difference is mainly in the state of the science at the time: i) The infectious agent (H1N1 influenza A virus) was mostly unknown; ii) researchers worked almost unprotected; iv) immunity was not fully understood, and less than ten illness were treated with vaccines; v) although facemask and handwashing were recommended, most routes of transmission were unknown. Make children imagine how helpless people felt at the time and help them think about how much more powerful our response is to COVID-19.

2. Science practiced in the real world

There is still a lot we do not know about this new virus, but the amount of information we do know increases daily in an unprecedented way. Based on previous findings in similar viruses and outbreaks and elaborate models, scientists urgently formulate and test hypotheses. Results provide knowledge more specific for SARS-CoV-2, allowing the formulation of new hypotheses. It is an occasion to explain to children that, in contrast to their shared beliefs, scientific knowledge is neither dogmatic nor static, but dynamic, and that science is a marathon, not a sprint.

3. The importance of accurate communication and cooperation among different fields of expertise

Children should learn that science is the result of cooperation. Interdisciplinarity is essential for controlling and minimizing the virus spread soon. Scientific discovery and development are collective efforts involving scientists from several disciplines and subdisciplines, each using specific jargon and methodologies. Communication among those scientists is critical to filling the knowledge gaps. For instance, epidemiologists may not understand airborne particle dynamics, whereas atmospheric chemists do not necessarily understand epidemiology. Emphasizing the need to bridge these two worlds provides students a perspective of what is needed to solve other global issues.

4. The importance of vocabulary and consistent definitions and terminologies

Language is vital in any educational setting. It must be accessible and be always rigorous. During the COVID-19 pandemic, there has been considerable ambiguity and confusion in the definitions of essential concepts related to potential disease transmission routes, starting from the concepts of “airborne transmission” and “droplet transmission” along with a dispute of what is an “aerosol,” a “small droplet” or a “large droplet.” In practice, terminology varies from person to person. Differences in the field-specific definitions and terminologies (jargon) related to the virus’s transmission

confuse both experts and the public. Ambiguities result in a severe misunderstanding between researchers, to the point that research findings are disconnected within disciplines.

An excellent example of this ambiguity and the resulting confusion is the term aerosol.

An aerosol is a suspension in the air (or in any gas) of solid or liquid particles, small enough to remain airborne for prolonged periods because of their low settling velocity.

To aerosol scientists, any particle—liquid or solid, nanometers to micrometers (μm) wide—forms an aerosol if suspended in the air. To other scientists, size matters;

aerosols are small, under $5\ \mu\text{m}$, and they believe that bigger particles are rapidly settling “droplets” (Klompas, Baker, & Rhee, 2020). That single fact has been a source of confusion these past few months since it determines COVID-19 forms of transmission, which conditions the efficiency of prevention measures such as ventilation and face masks.

5. Sometimes the problem is not a lack of information, but excess

The information storm —contrasted or not, disinterested or not— happens dizzyingly, causing a singularity in human history: a globalized and technologically connected world in real-time in which science advances at forced marches. Weekly there is an avalanche of new knowledge about SARS-CoV-2, thousands of articles —many of them of questionable quality— that the media interpret and transfer to the general public (Sharot & Sunstein, 2020). This avalanche results in an over-exposure to misinformation and disinformation, something unthinkable in another era, even in other recent pandemics such as HIV or the 2009 swine flu.

Science, as a process, can be messy. In a pandemic, every misstep —each of which would probably have made little stir if it were in a different area of science under other circumstances— will be magnified and politicized. There is a lot of noise and many

hoaxes. We need to keep that in mind and view with caution each discovery breathtakingly announced to the public. Teachers should explain to children that: i) scientists do not always agree; ii) science is a matter of consensus and teamwork, and iii) a single person may be wrong, even if he/she won a Nobel Prize. Teachers should provide trustworthy sources of information, train criticisms, and address common misconceptions in children. Science literacy is the best way to prevent misinformation and disinformation as well as its propagation through fake news “rumors” (Scheufele & Krause, 2019). This way, children will be ready to identify confinable sources of information to protect their health and maintain a critical position against unexpected new solutions from unknown sources.

6. The importance of contrasting information and of cultivating critical thinking

Global occurrences like the current COVID-19 pandemic reinforce the importance of developing critical thinking skills in students. An example of how developing critical thinking helps us know how to act (or how not to act): some local authorities ordered to fumigate to disinfect schools before reopening. Schools had been closed for several months. SARS-CoV-2 does not “survive” for longer than a few hours in aerosols or a few days on surfaces (Riddell, Goldie, Hill, Eagles, & Drew, 2020; Van Doremalen et al., 2020). Thus, scientific information tells us that places such as shops, retailers, bars, schools do not need to be disinfected before reopening after months of lockdown, since there is no longer any viable virus there. Critical thinking will let children understand that special precautions are necessary beyond those taken when returning after vacation.

7. We can use science to spot pseudoscience quickly

The global crisis can give rise to manipulating people by opportunistic groups through the falsification of information. News such as “5G wireless technology causes COVID-19” or “Cow urine and bleach cure the disease” (Caulfield, 2020) result in support of

negationist and an increase of acute poisoning, respectively. Some “cult figures” have a substantial widespread influence during the pandemic, taking advantage of the situation to push immune-boosting supplements and diets as a cure, for instance. Moreover, these persons use their notoriety to weigh in strongly on policy questions. Loosely moderated social media platforms largely contribute to the spread of fake news, hampering health policy initiatives (Caulfield, 2020). Children must know that science can help us to protect ourselves from rising misinformation and disinformation. In order to debunk misinformation, teachers can take advantage of their inherent credibility to provide reliable information. In the science curriculum, this information allows students to appreciate how science progresses and how it helps humankind understand the world. The training to spot misleading information can start when children are very young. Storytelling is an excellent way to do it. For instance, by using fairytales, teachers can discuss how a wily fox uses the language and the presentation and interpretation of facts and statistics to cheat the other animals (Henley, 2020). Teachers must carefully select the information to be corrected or debunked (such as a rumor spreading in the community), since otherwise, they may inadvertently help spread the misinformation (Caulfield, 2020).

Life processes and living things

1. A virus is not a living being

A virus is not a living being but a chemical-physical entity. Microbiology classifies these entities as “infectious agents” made of self-assembled biomolecules rather than cells. In SARS-CoV-2, one of these biomolecules (the spike) is a protein that acts like a key to unlock some human cells. SARS-CoV-2 is much smaller than bacteria and less

complex. Viruses offer an excellent opportunity to discuss into K-12 classrooms the seven characteristics of life (Koshland, 2002).

Two features of viruses, common to living beings, are their ability to reproduce (not autonomously but into a cellular host) and evolve (pass slightly modified traits onto its offspring that are eventually selected). In contrast to living beings, viruses are not nourished and are unable to grow. Viruses exhaled by a person cannot multiply in the air or on a table. Compared to airborne bacteria and fungi, viruses are more fragile out of their host (Tang, 2009) since they lack a critical characteristic of living beings: adaptability to environmental conditions. Viruses are more stable in the presence of organic material (such as in blood, feces, mucus, saliva), which tend to protect the virus against environmental changes (Tang, 2009). The first two studies on SARS-CoV-2 stability concluded that this virus “can be highly stable in a favorable environment, but it is also susceptible to standard disinfection methods” (Chin et al., 2020; Van Doremalen et al., 2020).

“Being alive” is sometimes a difficult concept for children (Sadler et al., 2013). They may believe that, since viruses move by passing from one person to another, they are alive, similarly to fire and clouds. In contrast, many children think that plants are not alive since they do not move. Youngest children may also be confused about the type of reproduction (i.e., no mother and father are required) (Sadler et al., 2013).

When viruses enter a person’s body, they can spread inside some of its cells. Viruses cannot enter into all human cell types but specific ones. Depending on the cell invaded, viruses cause different diseases like chickenpox, measles, flu, or COVID-19. SARS-CoV-2 enters, for instance, into cells in the upper respiratory tract, because these cells contain a lock (a surface cell protein named ACE2) that the spike protein of the virus can open. Once the virus goes inside a human cell, its genetic information (RNA in SARS-

CoV-2) controls it. As a result, cells that previously worked for the entire body start working for the invader to make thousands of virus copies (like in a plaster cast). This ability to reproduce often confuses many children, for whom reproduction is an attribute exclusive of living beings (Sadler et al., 2013).

2. *How is SARS-CoV-2 transmitted?*

When coughing, speaking, breathing, singing, talking, we emit thousands of respiratory particles of a wide range of sizes, which leave our bodies at different speeds, sometimes as a burst and other times more slowly. People sick with COVID-19 (even with mild or no symptoms) shed these particles virus-laden into the air (Prather, Wang, & Schooley, 2020). A common misconception is that SARS-CoV-2 spreads as individual particles of $0.12\text{ }\mu\text{m}$ or, as depicted in major medical journals and newspapers, coated by water (Fig. 1).

Figure 1: A common misconception is to believe that SARS-COV-2 is transmitted as individual particles (A) or as individual particles embedded in a little water (As in Scientific American, May 12, 2020) (B). However, this virus likely spreads in droplets of micrón size—credit: NIAID's Rocky Mountain Laboratories.

However, viruses travel in aerosols of a mixture of mucin, salt, and water of a few microns (Vejerano & Marr, 2018). The size of virus-laden particles is essential to understand how facemasks protect, virus stability, infection dose, and why some particles settle while others remain in the air for hours.

Another extended misconception is that wearing a facemask and keeping 2m from other individuals prevents COVID-19 transmission because this occurs mainly through droplets. This confusion derives from the use of unappropriated definitions. The medical community considers particles $>5\text{ }\mu\text{m}$ as droplets that rapidly drop to the

ground by gravity, typically within 1 to 2m of the source person. This community also considers particles $\leq 5 \mu\text{m}$ as aerosols that rapidly evaporate in the air (Klompas et al., 2020). However, this is far from the real behavior of exhaled particles. Humans produce respiratory droplets ranging from 0.1 to 1000 μm (Prather et al., 2020). Particles as wide as 75 μm diameter follow the air stream, are widely dispersed, and some remain in the air for hours (Chen, Zhang, Wei, Yen, & Li, 2020). Thus, keeping 2m apart is not enough to prevent COVID-19 transmission because aerosols can move more than 2m apart.

Objects and surfaces contaminated with these virus-laden particles become fomites, which potentially could transmit the virus. However, “despite consistent evidence as to SARS-CoV-2 contamination of surfaces and the survival of the virus on certain surfaces, there are no specific reports which have directly demonstrated fomite transmission” (World Health Organization, 2020). This contrasts with the airborne transmission, documented as the only possible route in many superspreading events (Miller et al., 2020; Shen et al., 2020).

Once exhaled, the virus disperses like air pollution particles, dust, pollen, or cigarette smoke. Teachers can use the following analogy: viruses in the air behave like the plume of smoke dispersing from a cigarette. The distance from a smoker at which one smells cigarette smoke indicates the distance in their surroundings at which one could inhale infectious aerosols (Prather et al., 2020). It is intuitive to recognize that this distance depends on ventilation. In other words, without wearing a mask, the safe distance would be that at which tobacco smoke does not smell. In a poorly ventilated classroom, there is no safe distance.

For children, smoke is familiar enough to be employed as an analog of virus-laden particles (the target). There are several similarities between this analog and the target: i)

it remains in the air; ii) it is more concentrated in front of the smoker; iii) air currents mix it; iv) it accumulates in poorly ventilated places, and, v) it impregnates materials. Children can imagine that others are exhaling smoke, and they want to breathe in as little smoke as possible, especially without a mask. That is how they can reduce the chance of infection. In the classroom, it is also essential to establish the limits of the analogy. This will prevent new misconceptions from arising. In contrast to smoke: i) the virus-laden particles do no smell and are not visible as a cloud of smoke ii) virus-laden particles do no penetrate the facemask as the smoke smell; iii) Smoke can impregnate in clothes or surfaces far longer than the virus can stay infective.

3. How SARS-CoV-2 enters into our organism?

SARS-CoV-2 does not enter into our organism through the skin (Chan et al., 2020; National Academies of Sciences, Engineering, 2020). This virus enters our body in two ways, either because we inhale it or because it is deposited in our mucous membranes (eyes, nose, and mouth), and from there, it reaches the respiratory tract. The deposition occurs by “landing” (or impact) of infected droplets or after touching the eyes, nose, or mouth with virus-contaminated hands. Airborne droplets move either as aerosols or ballistically (like projectiles). Airborne aerosols dominate SARS-CoV-2 transmission during close contact (Chen et al., 2020).

4. What is a vaccine?

A vaccine is like a description of a wanted criminal: it tells our immune cells whom to look out for. So long as the suspect’s appearance does not change too much, the vaccine works. Immunity may fade as our immune system forgets the picture that the vaccine showed it. For example, the flu virus that yearly infects us (and our immune system sees) is often only slightly different from one year to another. Our immune system is at least partially prepared, and so we are partly protected. Even if we get infected, it might

be a milder illness because our immune system can react more quickly to fight it off.

We still do not know how long our immune system will remember SARS-CoV-2 following infection.

5. Why is there hope in vaccines if there are no vaccines for other viruses?

No person infected with HIV, for example, has been cured thanks to their immune system naturally. That is because HIV infects our immune cells. It is a “cop killer.” Any immune cell that tries to go after HIV walks right into the virus’s arms. Instead, many people have overcome coronavirus infections thanks to the action of their immune system. Moreover, if we have been infected and have recovered from other kinds of coronavirus, we may have some level of immunity to COVID-19. Thus, if immune protection occurs naturally, it likely could occur artificially after vaccination since both natural and artificially immunity is based on a similar physiological response to fight viruses.

Materials, their properties, and physical processes

1. The importance of humidity

The importance of air humidity in SARS-COV-2 transmission is an example of integrative science. For a given temperature, relative humidity (RH) describes the amount of water held in the air relative to the maximum amount of water vapor that air could hold at that temperature. The same amount of water vapor results in higher RH in cold air than in warm air. RH determines the evaporation rate and settling of ejected respiratory particles and spit. The lower the humidity, the higher the droplets’ evaporation, reducing its size (Feng, Marchal, Sperry, & Yi, 2020). As a result, at low RH, virus-laden particles remain in the air for longer, allowing airborne transmission (Prather et al., 2020), while favoring the spread of viruses. Droplets generated during cough or speech are airborne under typical indoor conditions (e.g., RH < 50%) because

at this humidity, the evaporation time for water droplets is below their sedimentation time (Stadnytskyi, Bax, Bax, & Anfinrud, 2020).

RH influences not only the behavior of exhaled droplets but also virus stability. In general, viruses are more stable at low RH. For example, at 20-40 % of RH, they usually resist more than 50-60 % (Herfst et al., 2017). Besides contributing to the extent of dispersal and mode of transmission, respiratory droplet size affects disease severity (Prather et al., 2020).

RH may also be relevant at the level of the host. Breathing dry air causes desiccation of the nasal mucosa and could impair the host antiviral immunity, which would, in turn, render the host more susceptible to respiratory virus infections (Fisman, 2012).

2. Why does soap or alcohol inactivate the coronavirus?

A lipid (fat) coat covers SARS-CoV-2. Soaps, detergents, and alcohol are good at destroying this coat in seconds (EPA. & Agency, 2020). During handwashing, the combined action of soap and water effectively dissolves the fat envelop of the SARS-CoV-2 and the chemical interactions that hold the self-assembled biomolecules together. This inactivates the virus so that it can no longer infect cells. Moreover, it detaches it from the skin and causes it to fall apart like a house of cards. In addition to these effects of soap, alcohol dehydrates the virus, which cannot maintain its viability without water.

3. Separation of matter

Masks contain a layer of fibers that form a porous, breathable network. Mask filters look more like a tangle of bushes than a strainer. Many people mistakenly think that viruses spread from person to person as single SARS-CoV-2 particles (120 nm in diameter). They also believe that masks prevent virus inhalation because of trap particles like sized sieves. However, viruses spread in respiratory droplets of variable

size. Various physical and chemical phenomena intervene to trap particles. One of them is the electrostatic charge. The electrostatic charge of the fibers helps capture smaller particles that could slip through the holes. Electrostatic interaction is possible because particles and fibers are oppositely charged, attract each other, and link. That is why it is important not to immerse or spray the masks several times in alcohol or bleach. By doing so, the mask fibers lost its electrostatic charge, turning unable to block particles as effectively. A recent study shows the possibility to reuse one-time N95 facemasks if treated with 70% ethanol, and three times after using dry heat, 70 °C (Fischer et al., 2020), no more.

Brownian motion is also necessary to understand why the smallest particles do not seep through the pores, as many mistakenly believe. Mask filters can be very effective in retaining small particles because they have much random motion, almost like molecules. The way the air flows around the filter fibers makes the moving particles bump into those fibers and be retained. To explain this erratic movement—and why masks can more easily filter the smallest microscopic particles— teachers can use the analogy of a blindfolded person stumbling into chairs and walls while trying to cross a room. The particle is the blindfolded person, and the chairs are the fibers of the masks. The most challenging particles to catch are the medium ones (around $0.3\ \mu\text{m}$), not the small ones, as most people believe. For this reason, quality controls are made with particles of that size. If they pass the test, they will pass it even better with larger or smaller particles.

4. Physical and Chemical changes

The interest to rapidly inactivate SARS-CoV-2 may push to combine several disinfection strategies such as chemical compounds (bleach- sodium hypochlorite-, quaternary ammonium, and hydrogen peroxide) or temperatures (70 °C) effective

against the virus (Chin et al., 2020; EPA. & Agency, 2020). These must be avoided. In combination with bleach, ammonium (the conjugate acid of ammonia) or other acids, such as vinegar, will create highly toxic chlorine gas, burning the lungs, whereas mixing bleach and hydrogen peroxide results in an exothermic chemical reaction that releases oxygen and may splatter, causing skin and eye injury. Temperature accelerates these reactions. These are chemical reactions.

How this knowledge is useful to protect themselves and their students

Teachers should ensure that children understand what is essential to protect themselves and others. According to behavioral science (West et al., 2020) “the capability to undertake personal protective behaviors requires people to understand what needs to be done, under what precise circumstances it needs to be done, how to do it and why it is important. It also requires the development of appropriate skills and techniques”. This will engage students in protective behaviors rather than into the obligation to do something.

Mask wearing and other measures, such as social distance, affect social interaction, especially the emotional part. Communication does not occur naturally, especially in countries where daily physical contact is essential. Mask wearing could create social rejection and negative feelings of fear, anguish, and phobia. It is unclear how the physical distancing and other measures may influence the development of socioemotional skills of children and adolescents, like, for example, managing conflicts with their peers. It will affect social reference and other aspects of learning to a greater or lesser extent depending on the age of the child and its previous psychological conditions.

Early ages and adolescence are stages to watch very closely. Both stages are key because, until the end of childhood education, social reference continues to be configured as a vehicle for the child to learn to relate to the environment and peers. If the child has acquired the social reference well, he/she will be able to adapt better to the changes. In adolescence, socialization is also an essential factor.

The effects of wearing masks at school

The fact that teachers (and in some countries, also students) wear a mask could affect student learning. Many people think they have to remove their masks to be heard. Everyone should trust that sounds go through the mask. However, children are not going to be able to see the teachers' mouths, which is essential to express what they want to transmit. Younger children require vocal modeling (to learn how to pronounce the sounds of language) or more time for facial expression.

What can teachers do about it? We will need an adaptation period so that both students and teachers get used to using the mask and other measures and adapt to a new lifestyle. Some modifications should be made in the school environment, at a personal, organizational, and methodological level.

Keep in mind that face coverings may be challenging for students (especially younger students) to wear. More youthful children — particularly those in the earlier developmental stages — will find it more challenging to understand the importance of a mask. They will put their hands all over the mask, put it on and off, and bring it down below their nose. Students should be frequently reminded not to rid or touch the masks. To obtain maximal compliance, reasons for mask-wearing without attempts of removing it must be clearly explained (West et al., 2020). But children will not be forced (Esposito & Principi, 2020). Try to make it fun and educational. Give rewards for the

best mask and for those who leave their masks on the longest, etc. Teachers and staff should serve as of mask role models, to the extent possible (West et al., 2020).

When we wear a mask, we lose many skills in the speech mechanism. We have to reinforce the tools we have to compensate for what we are going to miss with the mask. Some changes at the teacher (personal) level could be: i) control the noise level in the classroom, ii) speak louder and slower (or use a microphone), and iii) repeat the message more times. Seek a multisensory education: greater kinesthetic support (movement of the body), and complimentary use of digital whiteboards and screens, and, if available, microphones. As for the organization, teachers must follow some guidelines. For example, placing the students in a “U” shape so that the teacher has a central position and that all children can access a more visual message.

It is important to send children a message of hope in this normalization of something abnormal. We have to take into account that masks are going to be an important element of protection in our lives, but also that they are going to be something temporary.

As for the psychological aspects, children (and many adults) associate the masks with risk, with an abnormal situation, with concern. We, as adults, have to teach them to manage those emotions. They will need more support, empathy, comfort, and answers to the unknowns they have. They must receive the security and protection message. It is crucial that the teachers manage to keep calmer, serenity, and even use humor and play so that the child can introduce something as alien as a mask into their daily life. It is advisable to interact with the children through games using the masks, for example, helping them to read what the eyes are saying or playing guessing expressions. The fact of making it look like a game allows them to have more control over something new. The child will perceive it in a non-threatening way, which is key to the influence it may have on its development.

Concluding remarks

Supporting social and emotional wellness is a crucial goal for the return to school. It is vital to reduce anxiety and emotional impact, not only on students but also on teachers. Sensitive and effective communication about COVID-19 has major benefits for children. Also, adherence to protective behaviors is critical to stop the pandemic. We outline how to integrate this knowledge into daily activities and lessons at school. Students' understanding of scientific fundamentals behind preventive measures will favor adherence to protective behaviors. The challenge is to strike a balance. We should manage to reduce the risk to children's physical health without harming their mental health.

Education can encourage students to align their behavior with disease prevention measures and control at home, school, and their community (West et al., 2020). In the longer term, this awareness will empower children and families to advocate for their participation in the containment of the pandemic. Enlist children as allies in control of COVID-19 is a vital challenge, especially crucial if there are several waves of infections.

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