Automated temperature measurement and sanitization totem construction for the municipal schools of Naviraí

Medição automatizada de temperatura e construção de totem de sanitização para as escolas municipais de Naviraí

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ABSTRACT
The world is currently facing a pandemic caused by the new coronavirus (SARS-CoV-2) with a significant impact in Brazil as well. The document "Manual on Biosafety for School Reopening in the Context of COVID-19" was released on July 24, 2020, by the Joaquim Venâncio Polytechnic School of Health (EPSJV/Fiocruz), providing suggestions for norms and guidelines for the resumption of classes. Among the suggested measures are: the allocation of isolation areas for suspected cases of COVID-19; installation of dispensers with 70% alcohol gel and temperature screening at entrances, circulation areas, and classrooms. Therefore, it is important to produce 70% alcohol gel dispensers and body temperature monitors. The opportunity at hand is to propose an action that simultaneously: 1. Raises awareness among students in the municipal schools of Naviraí city about the issues surrounding COVID-19, as well as its main preventive measures. 2. Empowers these students with some tools from the MAKER culture, such as Arduino, 3D modeling and printing, and programming. 3. With the objective of providing workshops for the production of Totem dispensers with integrated body temperature readers, targeting young people in the municipal education network.

Keywords: COVID-19, totem, prototyping, arduino.

RESUMO
O mundo enfrenta atualmente uma pandemia causada pelo novo coronavírus (SARS-CoV-2) com impacto significativo também no Brasil. O documento “Manual de Biossegurança para Reabertura Escolar no Contexto da COVID-19” foi lançado em 24 de julho de 2020, pela Escola Politécnica de Saúde Joaquim Venâncio (EPSJV/Fiocruz), trazendo sugestões de normas e orientações para a retomada das aulas. Entre as medidas sugeridas estão: a destinação de áreas de isolamento para casos suspeitos de COVID-19; instalação de dispensers com álcool gel 70% e triagem de temperatura nas entradas, áreas de circulação e salas de aula. Por isso, é importante produzir dispensadores de álcool gel 70% e monitores de temperatura corporal. A oportunidade que se apresenta é propor uma ação que, simultaneamente: 1. Conscientize os alunos das escolas municipais da cidade de Naviraí sobre as questões que envolvem o COVID-19, bem como suas principais medidas preventivas. 2. Capacitar esses alunos com algumas ferramentas da cultura MAKER, como Arduino, modelagem e impressão 3D e programação. 3. Com o objetivo de oferecer oficinas de produção de Totens dispensadores com leitores integrados de temperatura corporal, voltados para jovens da rede municipal de ensino.


1 INTRODUCTION
The world is currently facing a pandemic caused by the novel coronavirus (SARS-CoV-2) with a significant impact in Brazil as well. The medical community is still getting to know the behavior of this virus, and the consequences from a population perspective are very serious. All this knowledge is highly dynamic, so some behaviors are not yet well established. However, some essential prevention measures are well known, including hand hygiene, physical distancing, and the use of masks (BETZ, 2020).
Many of the strict measures implemented during the crisis are gradually being relaxed, and the country is cautiously and methodically preparing to start a return to in-person activities according to new coexistence standards. As part of the effort to restore the suspended societal activities due to the virus outbreak, thousands of primary, secondary, and high schools across the country closed in March 2020 in an attempt to contain the spread of SARS-CoV-2, which was considered an essential measure for pandemic control (ROZHNOVA et al., 2021). Preparing for the return of activities that will take place in a scenario of constant prevention is necessary during this reopening (SHENDELL et al., 2021).

The document "Manual on Biosafety for School Reopening in the Context of COVID-19" was released on 07/24/2020 by the Joaquim Venâncio Polytechnic School of Health (EPSJV/Fiocruz) and provides suggestions for rules and guidelines for the resumption of classes. Among the suggested measures are: designated isolation areas for suspected COVID-19 cases, installation of hand sanitizer dispensers with 70% alcohol gel, and temperature screening at entrances, common areas, and classrooms. Therefore, it is important to produce 70% alcohol gel dispensers and body temperature monitors.

The opportunity at hand is to propose an action that simultaneously: 1. Raises awareness among students from municipal schools in the city of Naviraí about the problems of COVID-19, as well as its main preventive measures. 2. Empowers these students with some tools from the maker culture, such as Arduino, 3D modeling and printing, and programming. 3. Provides the tools for implementing preventive measures, generating community engagement around them.

2 LITERATURE REVIEW

In a recent review, Russell et al. (2020) report that school closures reduced the peak of the related outbreak by an average of 29.7% and delayed the peak by a median of 11 days. According to a study conducted by Di Domenico et al. (2020) on the reopening of schools in the Île-de-France region, the curve of cases will lead to an increase in the number of COVID-19 cases in the following 2 months, even with lower transmission among children. This demonstrates the importance of implementing biosafety prevention measures upon returning to school, such as social distancing, individual protection, and personal hygiene. These new practices will be established through engaging members of the school communities, especially students and education professionals. Such
engagement does not occur spontaneously; this new behavior is generated through problematization, discussion, dissemination of scientific knowledge, preparation, and the adoption of new habits. It is necessary to emphasize the problem, discuss prophylaxis, and practice new habits. Therefore, it is necessary to propose and implement projects that can generate engagement within school communities.

3 PROCEDIMENTOS METODOLÓGICOS

The proposed approach and its structure are based on the methodology of Gamification. In turn, the workshop stages will be developed using some active methodologies, and the main pedagogical strategies are listed below:

1. Problem-based learning
2. Project-based learning (PBL)
3. Gamification
4. Peer learning

The active methodologies will structure the teaching and learning process of the participants. It is important to highlight the pursuit of intense engagement from those involved and the opportunities that active methodologies generate in terms of desire and imagination. The educator's perspective as a mediator of learning, as an equal who is willing to construct knowledge through cooperation, will be the guiding principle of the project. This approach brings the relationship between the participants and the dynamics of solving a current problem to the core of the process, which are the principles underlying this proposal.

In this regard, the learning pathway that has been developed and serves as the basis for organizing the workshops encompasses a methodological proposal structured in well-defined stages, each of which has been named a phase following the NATO phonetic alphabet:

Problem-based learning (I) was chosen as the methodology for the ALPHA phase, which provides an overview of the problem currently faced by humanity (the Sarscov2 pandemic).

In the BRAVO phase, project-based learning (II) will be of great importance in the workshops, as some notions of objectives, timelines, and goals will be addressed to give participants a perspective on solving a problem through projects that culminate in prototypes.
The third workshop stage, named the CHARLIE phase, will heavily utilize Gamification (III). The proposal moves in this direction, as the intensive use of platforms such as Tinkercad and Scratch opens up this opportunity.

As a collaborative game, the fourth stage is named the DELTA phase and involves an intense process of construction through maker culture. Therefore, the active methodology adopted is Peer Learning (IV).

The workshops are structured like a game, where players are encouraged to act collaboratively so that, by the end, participants are called upon to develop a dispenser to contribute to combating the pandemic in their community. Instead of explaining all the details of dispenser development, students will be invited to participate in real actions that stimulate the competence to be developed. This contingency will contribute to the teaching and learning process of the workshops.

The four phases of the workshop will be offered from an active perspective, with students at the center of learning and constructing knowledge based on a real problem, namely the need to prevent the spread of SARS-COV2 in the school community. Each phase will last approximately 6 hours, totaling the proposed project.

3.1 ALPHA PHASE: THE VIRUS AND PREVENTION

In the search for methods to prevent and reduce the risks of COVID-19 transmission in society, it is necessary for students to acquire basic knowledge about general characteristics of viruses, structure and replication, physical and chemical control, and notions of biosafety, so that they can develop hypotheses about health surveillance and personal hygiene.

It is essential to guide students in practical hand hygiene lessons, using soap and water, and, when not available, instruct them on the use of hand sanitizer, so they can understand its importance and effectiveness in disease prevention. This is because hands are one of the main vehicles for COVID-19 transmission. Additionally, students will be directed to perceive and biologically identify the importance of temperature measurement, considering that fever is one of the first symptoms exhibited by infected individuals.

3.2 BRAVO PHASE: PROTOTYPING AN ALCOHOL GEL DISPENSER

Once students have acquired knowledge related to personal hygiene procedures
and how to prevent COVID-19, they will be challenged to develop a prototype of a mechanical alcohol gel dispenser with a pedal, going through the stages of planning and assembly. After the dispenser is presented, topics on usability and accessibility will be addressed, as well as how dispensers can be modified to ensure that everyone can use them in a simple and efficient manner. In relation to these topics, the instructor will introduce electronic sensors that can optimize the functionality of the dispenser, transforming it from mechanical to automated.

3.3 CHARLIE PHASE: BASIC ELECTRONICS AND PROGRAMMING WITH SCRATCH

To develop the prototype of an automated dispenser, students will learn basic concepts of electronics. This activity will be initially conducted using the Tinkercad simulator, a free and intuitive prototyping environment. Once the circuit planning is complete, students will begin the prototyping process.

In order for the dispenser to have functionalities, it will be necessary to develop the logic for sensor execution. During this activity, students will be introduced to Scratch, a problem-based programming platform that compiles code for Arduino, the controller board used in the project. Tinkercad and Scratch are platforms that adopt methodologies and practices based on problem-solving, creativity, and innovation, allowing students to immerse themselves in the Maker environment.

3.4 DELTA PHASE: ASSEMBLY OF THE ELECTRONIC DISPENSER

With the dispenser structure built in Phase 2 and the automation project developed in Phase 3, students can begin assembling the automated dispenser by combining the mechanical structure with the controlling circuits and sensors. They will initiate testing and install the dispensers in designated hand hygiene stations.

Through project-based learning, the involved students will actively engage in the proposed project. Essential questions for project organization such as What? Why? Who? and For what purpose? are initially addressed, and the tools are made available with constant guidance so that participants can propose solutions using their creativity and respond to derived questions such as How? With what resources? Researched by whom? What is the product configuration?

The structure of the alcohol gel dispenser and body temperature sensors will be
made from 6mm MDF, with cuts and engravings made using the CNC Laser available at the Navirai campus' IFMaker. A recyclable bottle (e.g., olive or soluble coffee container) will be used for storing the 70% alcohol gel, which will be injected by a Mini DC Submersible Water Pump, microcontrolled by Arduino Uno, along with the Infrared Emitter Module + IR Receiver sensors that will sense the presence of a person and activate the pump to dispense the alcohol gel through a silicone hose. Temperature measurement will be performed using the MLX90615 temperature sensor, strategically placed with a high-power laser to visualize the point where the temperature measurement is taken, which can be displayed on the Monochrome OLED Display. The connections will be made according to the wiring diagram shown in Figure 2.

4 DISCUSSION AND ANALYSIS OF DATA

The automated totem was designed and constructed using Arduino architecture, resulting in the schematic shown in Figure 1. The Arduino initially used is an UNO R3 model, which will be powered by a 12V 10A switched-mode power supply. The electrical connections were enhanced using a 400-point breadboard. The sensor signals, as well as the display, were connected to the analog pins A4 and A5, while the presence sensor and relay were directly connected to digital pins 8 and -10, respectively. The electric pump was connected to the 12V power supply with switching controlled by the relay.

Figure 1: Schematic of the automated totem assembly using Arduino.
The Arduino programming was carried out using the flowchart shown in Figure 2(A). Initially, the Arduino detects the sensors and the display to initialize the programming (Figure 2(B)). Subsequently, the system enters a loop, reading the obstacle sensor. If the sensor does not detect the presence of a person, the main display shows "IFMS" and returns to reading after 1 second. However, if the sensor detects the presence of a person, the system reads the body temperature and displays the result on the screen. Afterward, the relay is activated for 0.33 seconds, triggering the electric pump to eject a considerable amount of 70% alcohol gel through the silicone hose for hand sanitization. The system waits for 2 seconds before taking a new measurement, and then it returns to the loop.

Figure 2: (A) Flowchart of Arduino operation; (B) Code used for automation.
The prototyping of the totem structure was designed to be assembled in a "Lego" style using raw 6mm MDF sheets, without the use of nails, screws, or glue for fixation. The elements for laser CNC cutting and the construction of the totem parts can be seen in Figure 3.

Figure 3: Elements for the construction of the totem parts.

So far, 40 students from the Municipal Elementary School Marechal Rondon in
Navirái-MS, in the municipal education network, have been trained in the production process until the prototype is ready. They have been learning to prevent and reduce the risks of COVID-19 transmission in society. They have prototyped an alcohol gel dispenser with laser CNC cutting and engraving (Figure 3). They have also learned basic electronics for Arduino assembly and simulated its preparation using Tinkercad software (Figure 1).

For the assembly of the totem (Figure 4), the development of students' skills is necessary. Therefore, the project enhances the scientific knowledge of the participating students in an interdisciplinary manner, significantly improving their mathematical reasoning, repertoire in biological and exact sciences, and their ability to work in a group. All these possibilities can be envisioned in the work methodology, but described briefly, they are generated from the study of the problem (viruses and the need for personal hygiene habits), the modeling and construction of the totems using 3D printers and CNC, the assembly of electronic components on the Arduino platform, and the necessary programming for its operation.

Figure 4: First model of the automated alcohol gel totem.

5 CONCLUSIONS

The automated totem of the project was effective in temperature measurement and hand hygiene, demonstrating that it is possible to develop a cost-effective equipment.

With the completion of the project, the construction of 4 (four) automated temperature measurement and hygiene totems is planned, which will be distributed to
participating municipal schools. In addition to the training of 160 students, who will develop all the skills mentioned above, contributing to a safer return to school in their respective schools.

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