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Construction of a message transmitter prototype as a pedagogical tool in reflective teaching

Construção de um protótipo de transmissor de mensagens como ferramenta pedagógica no ensino reflexivo

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Resumo

In this article, we intend to present the construction of a prototype of a digital message transmitter controlled by the user that sends, by means of radiofrequency and a computer terminal, a text message to another device placed up to 50 meters away. This project was designed as a pedagogical tool for the teacher to communicate with his students using a wireless device and at a distance in a practical way with low cost of materials. The tool can be built together in the classroom as a collaborative teaching-learning process, aiming at the development of students' autonomy through digital and technological literacy.

Keywords: Technological education; reflective teacher; message transmitter

Resumo

Neste artigo, pretendemos apresentar a construção de um protótipo de transmissor de mensagem digital controlado pelo usuário que envia, por meio de radiofrequência e de um terminal de computador, uma mensagem de texto para outro dispositivo colocado a até 50 metros de distância. Este projeto foi pensado como uma ferramenta pedagógica para o professor se comunicar com seus alunos usando um dispositivo sem fio e à distância de forma prática com baixo custo de materiais. A ferramenta pode ser construída conjuntamente em sala de aula como um processo de ensino-aprendizagem colaborativo, visando ao desenvolvimento da autonomia dos alunos através do letramento digital e tecnológico

Palavras-chaves: Educação tecnológica; professor reflexivo; transmissor de mensagens.

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1. Introduction

In actual society, more and more communication processes happen through digital means. Mobile technologies, especially communication and social networks, are increasingly present in students' daily lives (PRENSKY, 2010). Because of this, the topic of digital communication arouses the interest of students and, therefore, can be a great topic to develop a teaching-learning proposal from a STEM (Science, technology, engineering and math) perspective. Education involving STEM practices and knowledge involves the ability to experiment and formulate hypotheses, the basis for learning creative thinking, and allows the process of collaborative construction of knowledge, in a critical and reflective way, considering the social implications of learning objects. The STEM approach is very important, because it needs to be linked to social reflection and requires a deep understanding of aspects that constitute the reality of students, their interests and motivations (BYBEE, 2010).

In this perspective, our work, which aims to build a digital communication device, is proposed taking into account the digital context in which Brazilian basic education students are inserted and under an interactionist-constructivist educational paradigm, seeking to promote knowledge about the processes social and technological that involve the creation of this means of communication. For this, we will present a low-cost prototype, using few materials, to build a small receiver of messages typed on the computer for a screen located at a distance.

The proposition of activities of this type is relevant in post-modern society, which is constantly evolving in increasingly global networks which end up being part of people's daily lives. In addition, the understanding of the technological phenomenon is associated with a type of citizen minimally capable of recognizing their right of access to information and whose inclusion will also be associated with them being able to communicate digitally effectively (RIBEIRO, 2008). Considering the above exposition, we designed our prototype to contribute to the development of skills and abilities related to digital literacy according to the STEM approach.

The construction of equipment that simulates the communication process in sociotechnical matrices, involving information and devices, is an interesting opportunity to simulate the contact of students with electronic communication devices. The literature in the teaching field demonstrates that the construction of models contributes to the development of learning in basic education, especially when the practice is linked to well-established learning objectives, not having just an end in itself (SCHMITZ et al., 2020). That is, it must be part of a pedagogical proposal, as outlined in the Common Curriculum Base in Brazil (BNCC, 2018).

Our prototype is based on digital communication processes. One of the interesting aspects of developing physical and technological prototypes like this one, based on electronic components and which also contain computing, is that online and digital education, usually thought of as digital games and applications or software, often does not include building the hardware. that supports the software and gives rise to several other technologies such as communication. It is clear that the prototype presented in this article is already known to the electronic community in general and is not an innovation created by the proponents of the text, however, its insertion in a reflection on education and in a pedagogical proposal is valid and justifies the text.

The prototype has a structure that is not complex, being composed of two small plates, one being mobile, in the hand of a student, and the other connected to a computer by a cable. Both boards are made with relatively low cost materials. Then there's the software, which is programmed on a computer using free programming platforms. How to use the prototype? For this, students will need a computer. First, they must open an executable file that can be on their desktop or in a folder, run it and it prompts them to type a short phrase on the keyboard. This phrase will then be sent by the program through the computer's communication with a small physical card, the transmitter, which will be physically connected to the computer. The transmitter sends the signal to the antenna that is far away. The antenna picks up the signal and then the message is processed and shown on the display screen to the student who is far away.

2. Building the prototype

2.1 List of materials

For implementation in a school and considering the possibility of cost reduction, we propose the construction of the prototype using the list of materials in Table 1.

Table 1 – List of materials

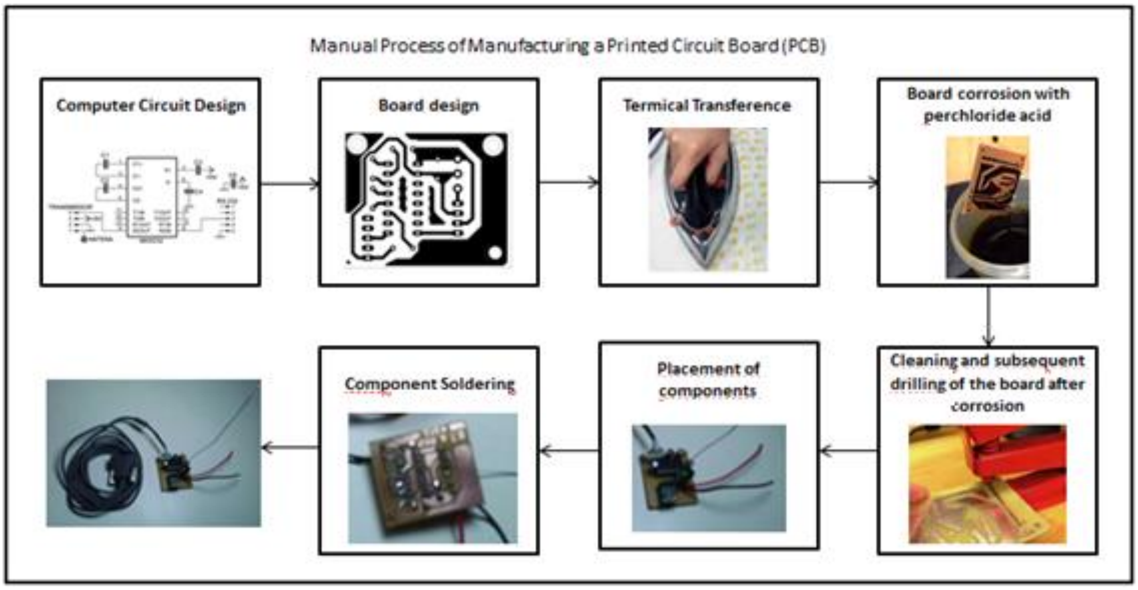
Code	Description	Quantity
001	Phenolite board – dimensions: 5x5cm	1
002	DB09 female connector w/ RS232 cable	1
003	100nF polyester capacitor	1
004	Electrolytic Capacitor 10uF 50V	4
005	Stamped 8-pin CI socket	2
006	14 pin CI socket	1
007	MAX232 Integrated Circuit	1
008	TXA1-434-F11 433MHz RF Transmitter	1
009	10x10cm phenolite board	1
010	7805 voltage regulator	1
011	100nF polyester capacitor	2
012	UHF L/C 433 MHz RF receiver	1
013	100nF polyester capacitor	1
014	Stamped 20-pin CI socket	1
015	PIC 16F690 microcontroller	1
016	Resistor 0.25W 470Ω ± 5%	1
017	5mm green diffused LED (1)	1
018	16 pin bus	1
019	Display LCD 16x2 INTECH ITM1602B	1
020	Iron	1
021	Perchloride acid powder	1
022	Piece of string	1
023	Plate punch	1

Source: the authors (2022)

The main part of the prototype consists of a phenolite board with a 16x2 LCD display on which messages of up to 16 characters created by the students on the computer can be shown. The system is controlled by a PIC 16F690 microcontroller, with PC-PIC communication via radio frequency (RF). The transmission occurs from the execution of a file with little memory and fast and practical sending and the reception occurs in another compact circuit that can be read in small distances.

Building the transmitter involves designing the circuit in software that allows for the design of the board. The circuit is divided into two systems: the message transmission system and the reception and display system. The manual manufacturing process requires some materials: a 500g unit of powdered acid perchloride, a bucket or similar plastic container, a plate punch, an iron, electricity. The steps are described in Figure 1.

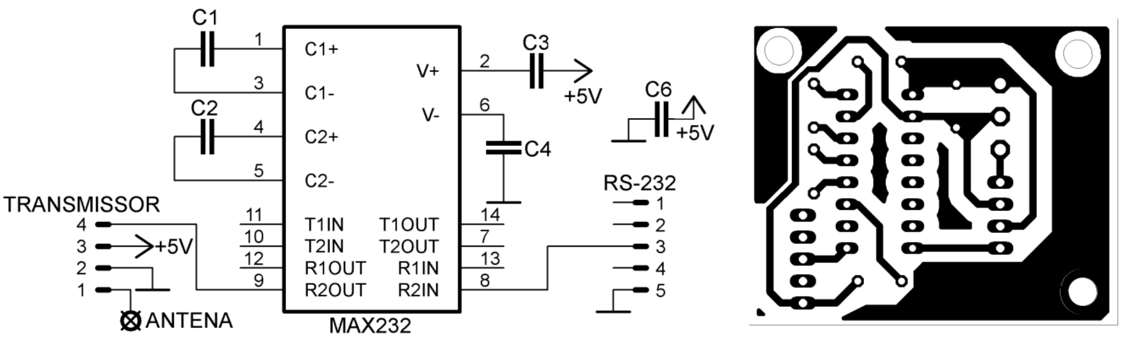
Figure 1 - Manual Process for Manufacturing a Printed Circuit Board (PCB)



Source: the authors (2022)

In this phase, the MAX 232 converts RS232 signals into TTL and forwards them to a resonator transmitter. The MAX 232 is the most widely used level converter in such applications, being resistant to shorts and discharges and excellent noise rejection. Below (Figure 2) is the schematic diagram of the circuit, of the board developed in Eagle 5.1 software and the board to be printed and built.

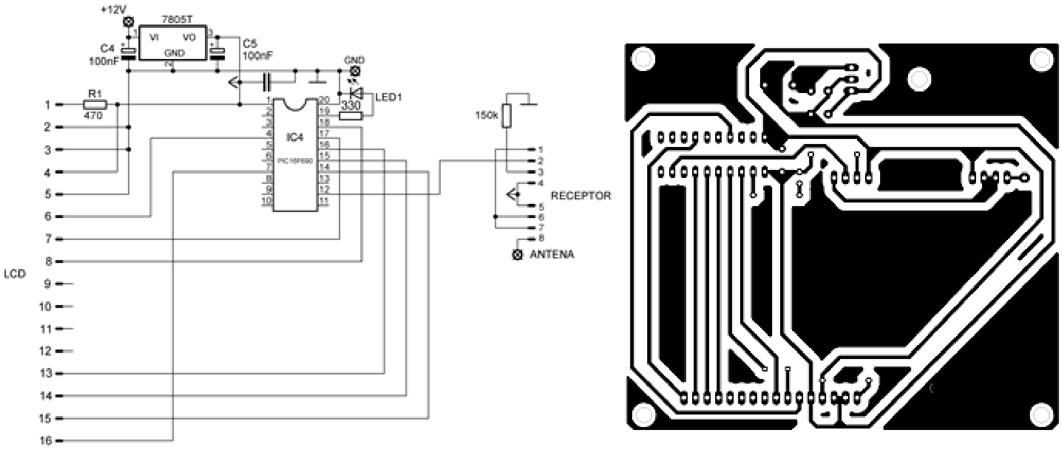
Figure 2 - Schematic Drawing and Eagle Software Board (Circuit Line Drawing)



Source: the authors (2022)

For the message reception and display system, we propose the following configuration. The receiver used operates in the range of 292 to 433 MHz. In this step, the data are captured and sent to the PIC16F690, which processes the signals and, using the C language, displays them on a 16x2 LCD display. The schematic diagram of the circuit and the developed board are shown in Figure 3.

Figure 3 - Schematic Drawing of the Message Receiver and its Board (Circuit Drawing)

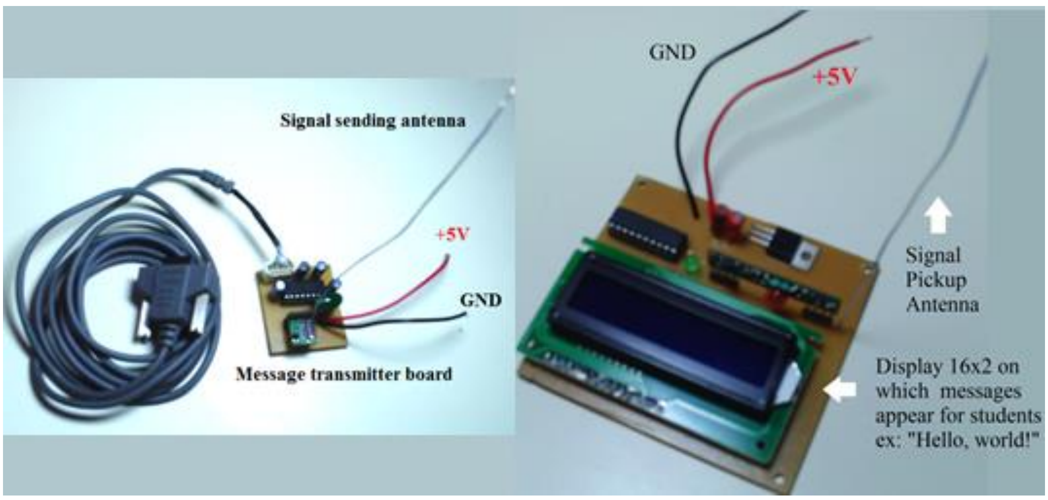


Source: the authors (2022)

The receiving circuit receives the signals from the TXA1-434-F11 type RF transmitter using its respective UHF L/C receiver and sends them to a PIC 16F690 microcontroller for data processing and visualization on the INTECH ITM1602B 16x2 LCD display. The circuit also has an LED, indicating the receipt of a new message and can be powered with 9 or 12V, as it has an LM7805 regulator so that the supply voltage stabilizes at 5V. For the correct compilation of the project, it is necessary to include the libraries and configure the display, which can be seen in the “Discussion” section.

After assembling the physical system of the prototype, the resulting device is shown in Figure 4.

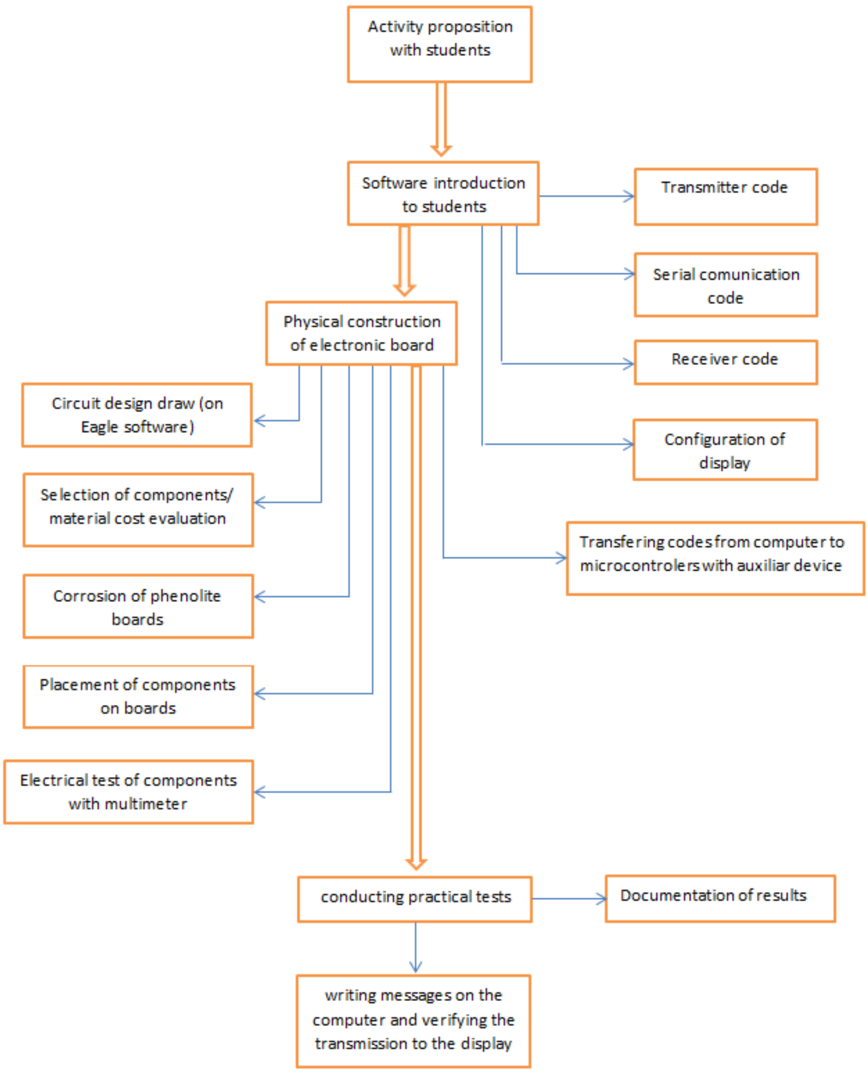
Figure 4 - Transmitter board (TX) and receiver board (RX)



Source: the authors (2022)

The complete activity requires a planning of days, depending on the availability of the students and the teacher, the laboratories and the conditions for the construction of the prototypes. An example of the distribution of the steps involved, such as a model that can be modified, but starting from the base, is described in the flowchart (Figure 5).

Figure 5 - Flowchart of the stages of scientific activity



Source: the authors (2022)

2.2 How the prototype works

When the whole system is ready, the serial interrupt function performs a test: if any interrupt is detected by the RCIF flag, it is tested to verify that there is no error, and if there is not, the data will be assigned to BYTE_RX. The acknowledgment signal function serves to reduce reception noise, as it waits for the PIC to receive three 'u', an 'A' and a 'z', at which point it will acknowledge the transmitter, which always sends 'uuuAz' before any new message.

The sender sends the strings using a timing that increments the string's position, with each character being sent at a rate of 2400 bits/sec. Inside the main function, there is an infinite loop composed of another while (can be seen in the program) that is responsible for waiting for a switch case statement to enter condition 3 (which indicates the end of the sent vector: \ 0), when it starts to consider the transmitter data. Then, it is tested if any data was received, through the if command (RCREG==1). If RCREG=1, the LCD will be initialized, it will go to the second line, the message will be written and the LED will be activated. When no data is received, the LED will remain off. The lcd.h library used appears in the report, as it required changes such as changing from PORTD to PORTC, to adjust to the PIC16F690 that does not have PORTD.

An Arduino can also be used to replace the microcontroller, since it has other pre-made modules that can be easily adapted and facilitate development, since it does not require the physical construction of the boards. Arduino can also have a more didactic use for the school reality, since it can be simulated using the free and educational software Tinkercad (AUTODESK, 2022). With it, you can adapt the inputs and outputs of the microcontroller and make some hardware changes, maintaining the proposal or improving it, with a view to developing a pedagogical activity with the students. In several countries, in robotics and technology classes, prototypes like this have been used in teaching.

The use of Tinkercad modules included in the Arduino R3 electronic board, one of the simplest, can allow a redesign of the activity circuit. The software is easy to use and has a tab in which the codes for each Arduino are included. The general interface allows adding components through the sidebar and is quite intuitive. Internet access is necessary for students to be able to draw on the website, which is already designed to, free of charge, provide conditions to be a tool for the development of students' digital literacy.

3. Discussion

In the proposal to actively develop the prototype, since the activity must be playful and allow students to learn, we suggest a didactic activity for development in basic education. One of the ways to use the prototype would be to use it as part of or associated with a game. According to Moran, one of the characteristics of games is that they must have the ability to adapt to the players' profile. In this sense, the prototype must be used for the students' apprehension of important concepts, which can be selected from an Ausubelian perspective, using conceptual maps for the construction of activities that start from the students' previous knowledge.

The interesting side of the project is that students can receive written information from other students with this equipment, as one person writes on the computer and the message is sent through the serial port to a second person. In this way, students will be able to understand the telecommunications system, the cellular network and the interpersonal contact system. In addition, it is possible to propose activities with access to little information between two groups, test behavioral responses, discuss aspects related to language and technology, and also promote ubiquitous education and digital literacy, developing relationships between digital and electronic analog. . In addition, financial issues associated with the cost of materials and the manufacture of the two boards, the project as a whole and time management can be discussed. There are, therefore, numerous activities that can be developed from the making of these prototypes.

For Krasilchik (2008), teaching is better when the teacher can identify how and why students learn, identifying their motivation to keep the class interested and willing to learn. With this, the teacher begins to reflect on his role and encourages students to seek new paths to knowledge. We know that today's society is articulated with digital media and much of the communication happens through electronic devices. It must also be considered that these technologies also cause social inequalities, since those who are behind the technologies end up being marginalized from the others. In this sense, the construction of electronic technology by students must be thought of as something existing within the reality in which students live, in their surroundings, in the culture in which they are inserted, in what they consume and what influences them, bringing students closer to technologies.

Communication and information technologies and the use of computers in educational activities can enhance improvements in the pedagogical practices of schools, developing skills and allowing the construction of autonomy by overcoming challenges and understanding the social place that is occupied, considering education as a form of broadening horizons. Digital educational technologies, as interactive devices that enable learning, have interactivity as a central feature, allowing a new way of relating human beings to machines (HOFFMAN, BARBOSA; MARTINS, 2016). For Freire (1996), education should aim at building students' autonomy, so that education is not merely a transfer of knowledge, but the creation of possibilities in order for them to critically produce knowledge, taking into account the reality in which they live. are inserted.

When the teacher places himself as a mediator in the teaching-learning process and not as a mere transmitter, he places the students within the process of building the activity with the prototype itself. Thus, in the activity with the prototype, the students reconfigure the flowchart, as the activity does not happen only after the prototype is ready and can be used for tests with electrical signals. The activity with the students takes place from the beginning and can be thought of together with the students and not for them.

Although the technology has a very simple firmware, which does not receive much data from patients, perhaps improvements can be considered in the sense of approaching an entity concept. According to Barbosa (2014), systems can know a user and their context. The entity can be a person, a moving object or a property or even a computer system. When knowing a user, a system must be open to know his context, that is, collect user data, and take into account aspects of the social world in which that person is inserted. In this sense, the prototype lacks a construction of its software that processes information of this order. However, a prototype starting from the same hardware can be improved to work with this information, considering that it has a microcontroller to insert the programming. students within the process of building the activity with the prototype itself. Thus, in the activity with the prototype, the students reconfigure the flowchart, as the activity does not happen only after the prototype is ready and can be used for tests with electrical signals. The activity with the students takes place from the beginning and can be thought of together with the students and not only for them.

3.1 Supplementary material

- Serial broadcast software - for the serial transmission performed in our prototype, we wrote the code, which can be verified in the supplementary materials or in the following link: https://github.com/beternus/messagetransmitter/blob/main/softwarepc.cpp
- Messaging software - the software requires 160 lines of DEVC++ code and is described here to be easily implemented by students and people in general. The code is available on the GitHub profile below, with each piece of code explained in the same file.
- Message receiving software - the message reception software was developed from MPLAB v8.60, executed by the PIC 16F690 microcontroller and can be seen below, with the logical description of the commands. It is also necessary to make some changes to the lcd.h library, which is included in the software: https://github.com/beternus/messagetransmitter/blob/main/messagereceiver.cpp
- Display configuration software - it is possible to configure the properties of the LCD display for a better visualization of the information. Some possible parameterizations can be seen in the next link: https://github.com/beternus/messagetransmitter/blob/main/lcdparametrization.cpp

4. Final considerations

Considering the importance of technological literacy, which is essential in today's world as a way of promoting social inclusion and preparing new generations to live in a growing digital reality, this activity is an example of a challenge that involves the need to overcome certain technological stages and develop practical skills and technical skills. At the same time, it can be important to develop some soft skills, such as collaboration and teamwork, since it is necessary for students to work as a team to send the message and receive it from a distance.

The prototype involves both electronic design and program/software coding and allows students to get involved in the STEM area and move towards acquiring multidisciplinary knowledge in their training. Personal development is promoted from the planning of the construction, discussion of the possibilities of the material and temporal resources available, in an activity in which, in order to walk, it is necessary to trust the other person and commit to its accomplishment.

The proposal is, therefore, an excellent way to combine practical and theoretical knowledge of electronic engineering, financial management, design and science teaching, allowing students to understand the process of developing a prototype, even when not associated with a consumer or client. end, having only an educational purpose. At the end of the activity, students are expected to be able to send a message via the computer keyboard and view it on a screen located fifty meters away and powered by a battery, but without the ability to receive the message back. on the computer. In this case, the return of information must occur by cell phone or other form of digital or physical communication. From the code and hardware available for free, anyone can make changes to the existing circuit, propose other functionalities and also theoretical discussions or practical purposes.

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