



Artigo Científico

ALTERNATIVE METHODOLOGY SIMULATING CAMERA LUCIDA FOR DRAWING MICROSCOPIC IMAGES

Metodologia alternativa simulando câmara clara para desenhar imagens microscópicas

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Resumo: A câmara clara é um antigo equipamento utilizado até os dias de hoje para ilustrar imagens ao microscópio e à lupa. Apesar de não ser um equipamento demasiadamente caro, pode ser inacessível a alguns laboratórios, bem como possui certos inconvenientes que podem ser facilmente superados com a tecnologia atual. O presente trabalho teve como objetivo desenvolver testar uma técnica que visa a substituir a câmara clara. Para esse fim, foi utilizado um microscópio, um smartphone, um computador com impressora e uma mesa de luz construída com material de baixo custo, cujos esquemas de construção constam de forma detalhada no presente trabalho. Foi obtida uma micrografia com o smartphone posicionado na ocular do microscópio. A micrografia foi impressa em uma folha de papel A4 que foi aderida à mesa de luz e, sobre a imagem, foi acondicionada uma segunda folha de papel. Com a mesa de luz acesa, a imagem impressa se tornou bem visível na folha de papel em branco por transparência, sendo então facilmente desenhada. Conclui-se que a técnica aqui descrita permite ótimos resultados, sendo uma alternativa eficiente para a câmara clara em equipamentos ópticos.

Palavras-chave: anatomia, ilustração, método de baixo custo, micrografia, técnica.

Abstract: The camera lucida is an ancient equipment that is still used today to illustrate images through a microscope and stereomicroscope. Although it is not an overly expensive equipment, it can be inaccessible to some laboratories, and it has certain drawbacks that can be easily overcome with current technology. This work aimed at developing and testing a technique to replace the camera lucida. To this end, a microscope, a smartphone, a computer with a printer, and a light table made with low-cost materials were used, whose construction schemes are detailed in this work. A micrograph was obtained with the smartphone positioned in the microscope eyepiece. The micrograph was printed on an A4 paper sheet that was adhered to the light table, and, over the image, was placed a second paper sheet. With the light table turned on, the printed image became clearly visible on the blank paper sheet by transparency and could then be easily drawn. It is concluded that the technique described here allows excellent results, being an efficient alternative to the camera lucida in optical equipment.

Keywords: anatomy, illustration, inexpensive method, micrograph, technique.

INTRODUCTION

The camera lucida is an ancient optical device used to perform more reliable illustrations. This equipment replaced the camera obscura, which was previously used for this purpose, as it was more portable and provided less distorted images (WOLLASTON, 1807). Ever since long ago, it has been used to create illustrations of microscopic images, and there were already different models to be attached to the microscope in the 19th century (CRISP, 1879; RUSSEL & LANCASTER, 1879). Even after the advent of the photomicrograph acquisition technique in 1840, the camera lucida continued to be used, either due to the high costs of equipment and processes for acquiring photographs, or due to the greater possibility and freedom to emphasize certain details of the structure to be illustrated (LAWSON, 1972).

To use a camera lucida, you need equipment that is compatible with the microscope or stereomicroscope. It is possible to install a non-specific camera lucida on a microscope or stereomicroscope by making adaptations (DAVIS & BOWMAN, 1954), but in this case, using it may lead to some limitations. If the camera lucida is from a model that is installed in the microscope eyepiece, it can cause some discomfort to the observer. If it is installed between the eyepiece tube and the arm, that is, if it changes the optical length between the objective lens and the eyepiece, it will require the use of an objective lens corrected for infinity. Because it is a long accessory, forming a lateral extension, it is necessary to add it to and remove it from the microscope or stereomicroscope, and this procedure, if performed by inexperienced or clumsy people, may damage the equipment. Still considering the dimensions of the camera lucida, its own weight or mechanical shocks may damage the camera lucida, the microscope, or the stereomicroscope. In addition, it is unfeasible or, at least, inefficient to illustrate moving or swimming cells under a microscope, or living animals, or plants susceptible to rapid drying under a stereomicroscope. Finally, it is a piece of equipment whose cost may be inaccessible to laboratories with financial resource limitations. Therefore, the conventional camera lucida has several disadvantages.

With the growing technological evolution nowadays, it is possible to develop alternative techniques and equipment for camera lucida use, however, these solutions are often relatively expensive because they use electronic equipment (COLEMAN, 2006; CHETVERIKOV, 2016) and, therefore, inaccessible to teaching and research institutions with financial resources limitations. Also, various softwares can be used to make drawings from micrographs (COLEMAN, 2003; SIDORCHUK & VORONTSOV, 2014; VAHABI *et al.*, 2021), however, although they can be practical and efficient for those with experience, the use of specific image editing software requires learning and practice. In addition, such softwares are not always free and require updates and compatibility with the user's computer operating system.

Thus, this work aimed at developing, testing, and evaluating a low-cost technique to replace the conventional camera lucida in a microscope.

MATERIAL AND METHODS

For this work, a binocular biological microscope, a smartphone, a computer, a printer, paper, a pencil, an eraser, duct tape, and a handmade light table were used. To make the light table, the following materials were needed:

- 10 mm thick plywood – 90 x 50 cm.
- Metal corner brackets for cabinets, with flaps measuring 1.5 x 1.2 mm (can be used with 1” flaps) – 4 pcs.
- Plastic shoes for ottoman with their respective screws, measuring no more than 4 cm in diameter – 4 pcs.



- Clear glass plate or with a sandblasted face, 6 mm thick and polished edges, measuring 43.2 x 30.5 cm – 1 pc.
- Piece of sheet metal about 0.5 mm thick, measuring 9 x 1.5 cm – 1 pc.
- 2 x 2.5 mm parallel wire – 3 m.
- 4.5 x 30 mm Phillips flat or truss head screws – 24 pcs.
- 4.5 x 20 mm Phillips flat or truss head screws – 10 pcs.
- 4.5 x 10 mm Phillips flat or truss head screws – 2 pcs.
- 3.5 x 10 mm Phillips flat or truss head screws – 4 pcs.
- Porcelain light sockets with their respective screws – 2 pcs.
- Lever switch – 1 pc.
- 10 A 2 pin male plug – 1 pc.
- 15 W compact fluorescent lamps – 2 pcs.

Basic tools were used to build the light table, such as a Phillips screwdriver, jigsaw, drill, wire cutters, file, and sandpaper. Figures 1 to 7 illustrate the measurements and positioning of the parts for the construction of the light table.

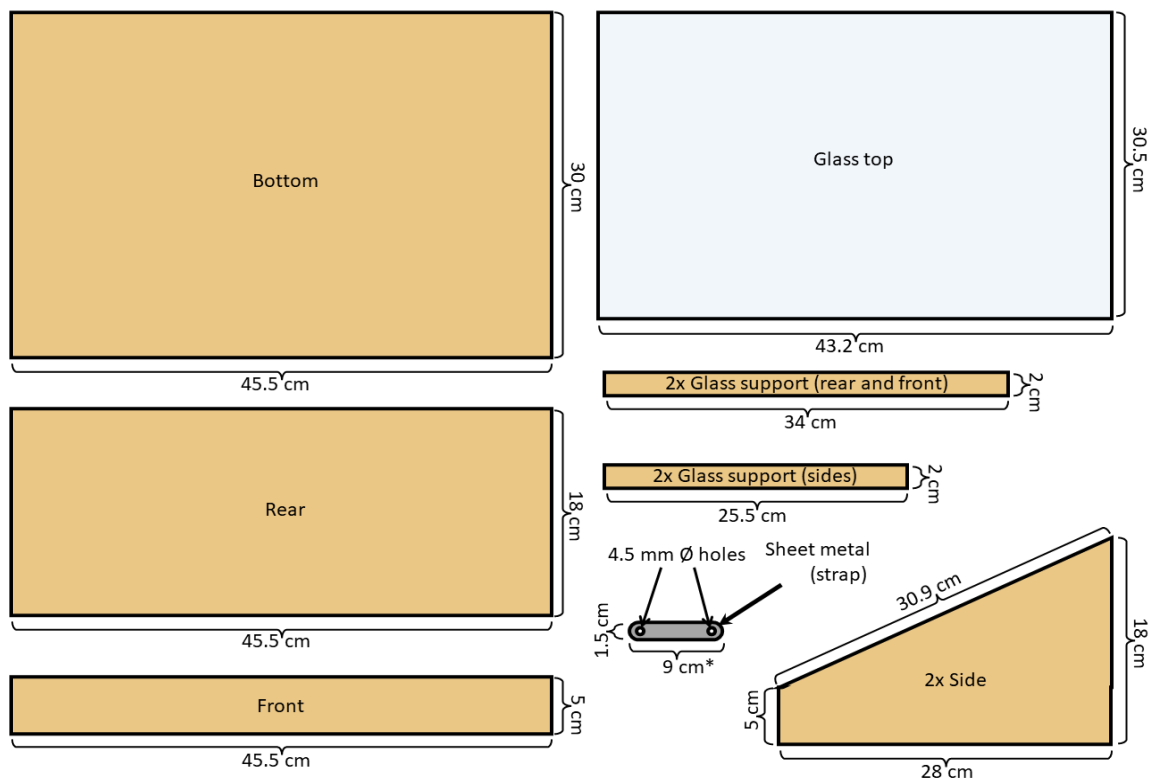


Figure 1. Schematics of the pieces to be made for the construction of the light table, showing the respective measurements. The pieces in beige are made from 10 mm thick plywood.

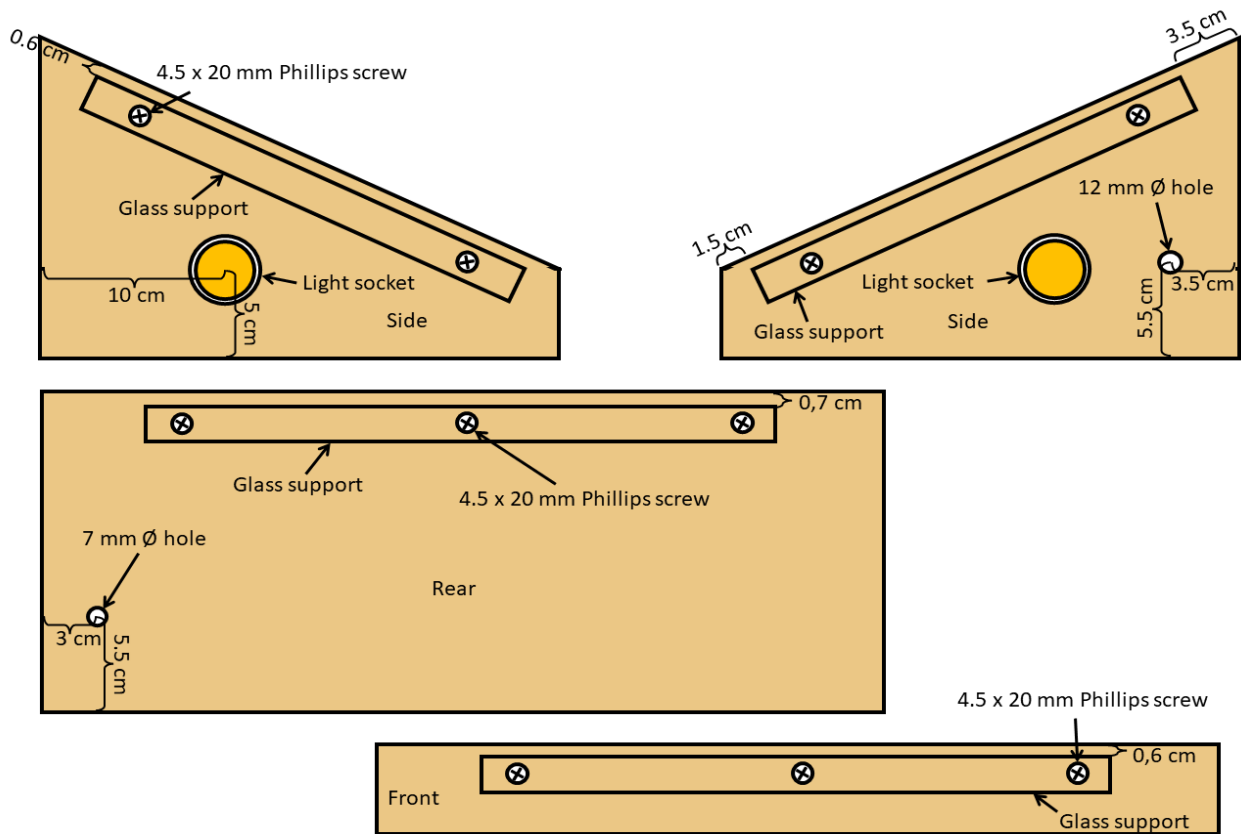


Figure 2. Schematics of the sides, rear, and front of the light table, observed from the internal face, showing the respective measurements of the positioning of the pieces adhered in the first stage of assembly.

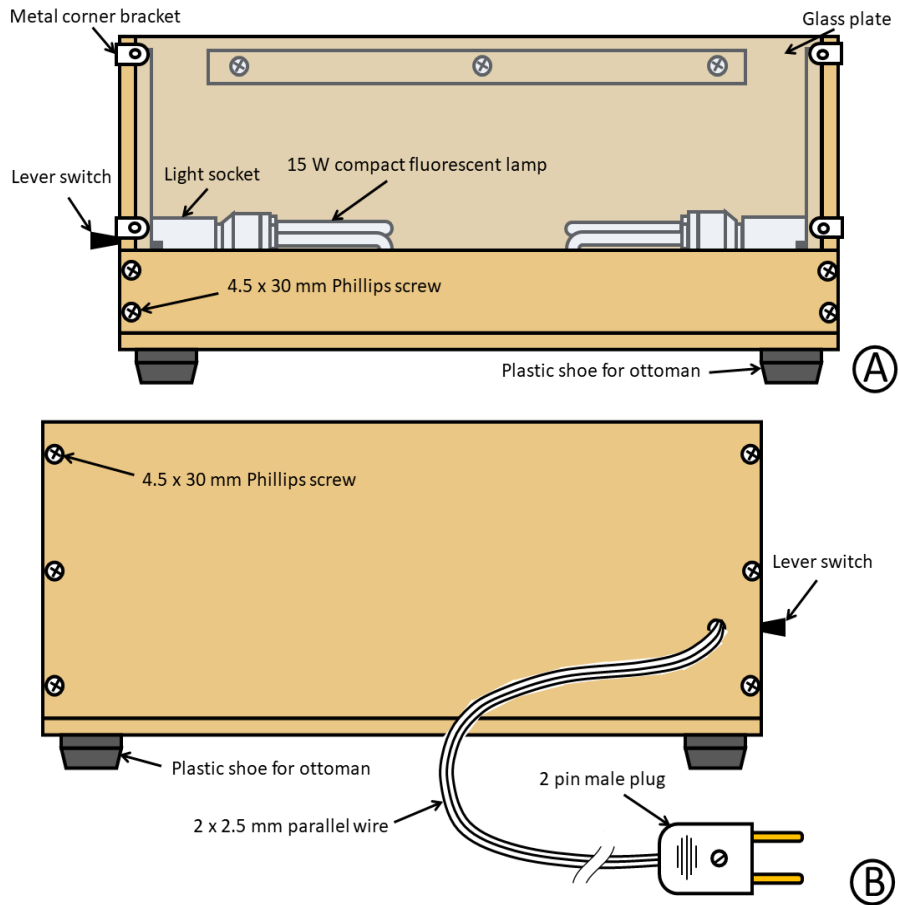


Figure 3. Schematics of the light table properly assembled. (A) Front view. (B) Rear view.

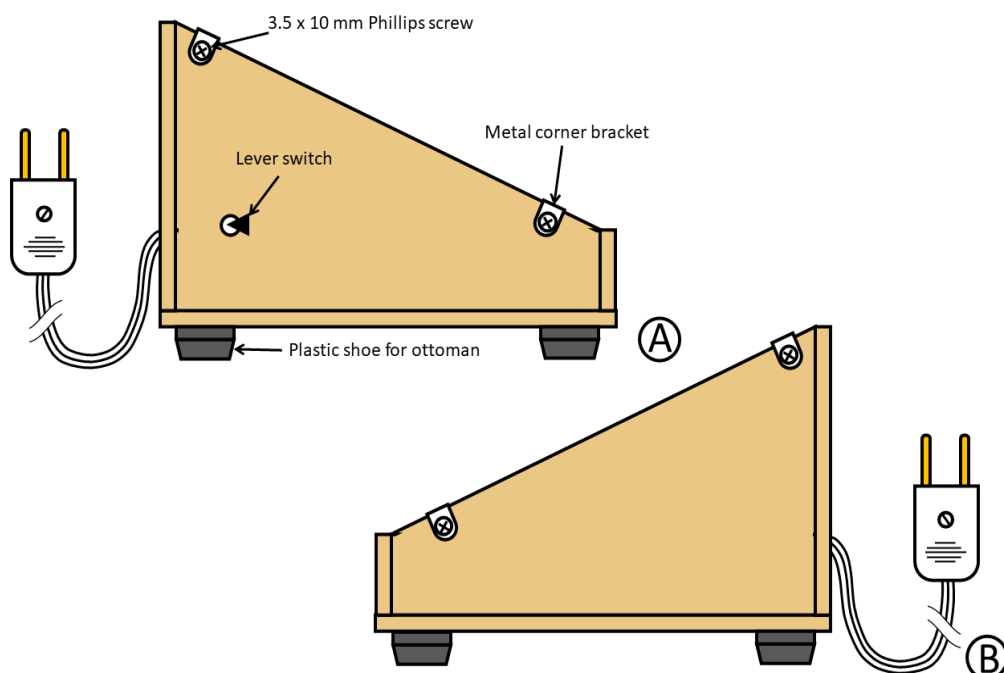


Figure 4. Schematics of the light table properly assembled. (A) Right side view. (B) Left side view.

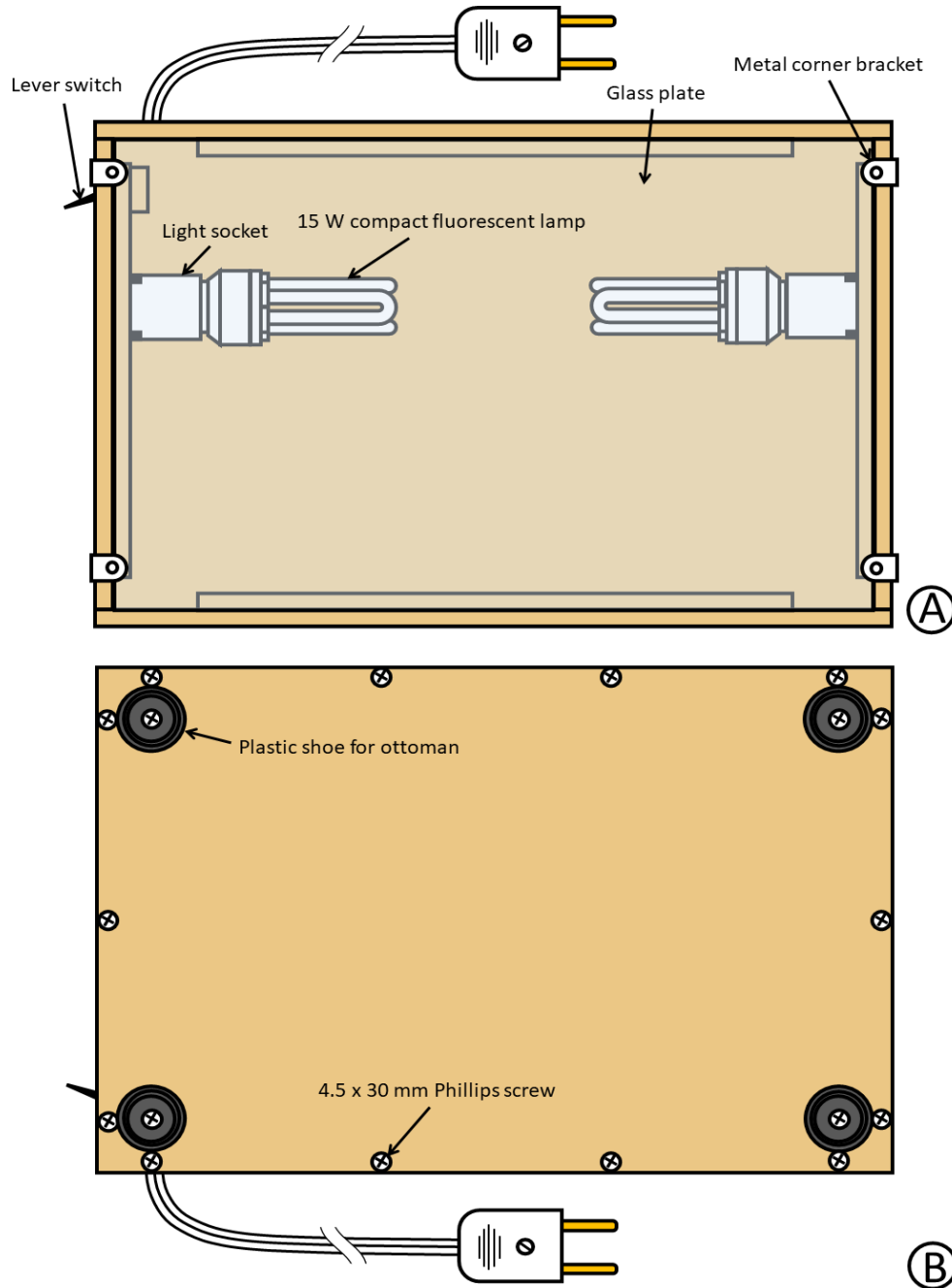


Figure 5. Schematics of the light table properly assembled. (A) Top view. (B) Bottom view.

A micrograph was acquired using a smartphone, according to the procedure described by Leitão (2020) (Fig. 8A). This micrograph was printed on an A4 paper sheet, which was affixed to the glass of the light table using duct tape (Fig. 8B). Over the printed image on this paper sheet, a blank A4 paper sheet was placed, also affixed with duct tape to the light table glass (Fig. 8C). The light table was turned on and, by transparency, the printed image became visible. With a pencil, the micrograph was drawn on the blank sheet of paper. For those details that were not clear in the print, consultations were eventually made to the micrograph in the smartphone's image gallery while the drawing was being made.

RESULTS AND DISCUSSION

The least expensive methodology possible was adopted in this work. Obviously, a photomicroscope could have been used to acquire the image, as well as one of the countless industrial light table models on the market. If resources are scarce, a light table can even be improvised by supporting a glass plate on two piles of books, using a lamp or a flashlight positioned below the glass plate as a light source. In this case, it is necessary that the glass or acrylic plate be sufficiently thick and resistant, and the edges be properly sanded or polished to be handled with due safety.

The light table design presented here has been assembled and properly tested, but it can be modified according to the availability of materials, as well as improved for better comfort or performance, or simplified for greater economy. In the latter case, the light table could be assembled without the switch and using only a single lamp, which can be attached to the center of the rear of the light table, at the same height of 5 cm from the bottom.

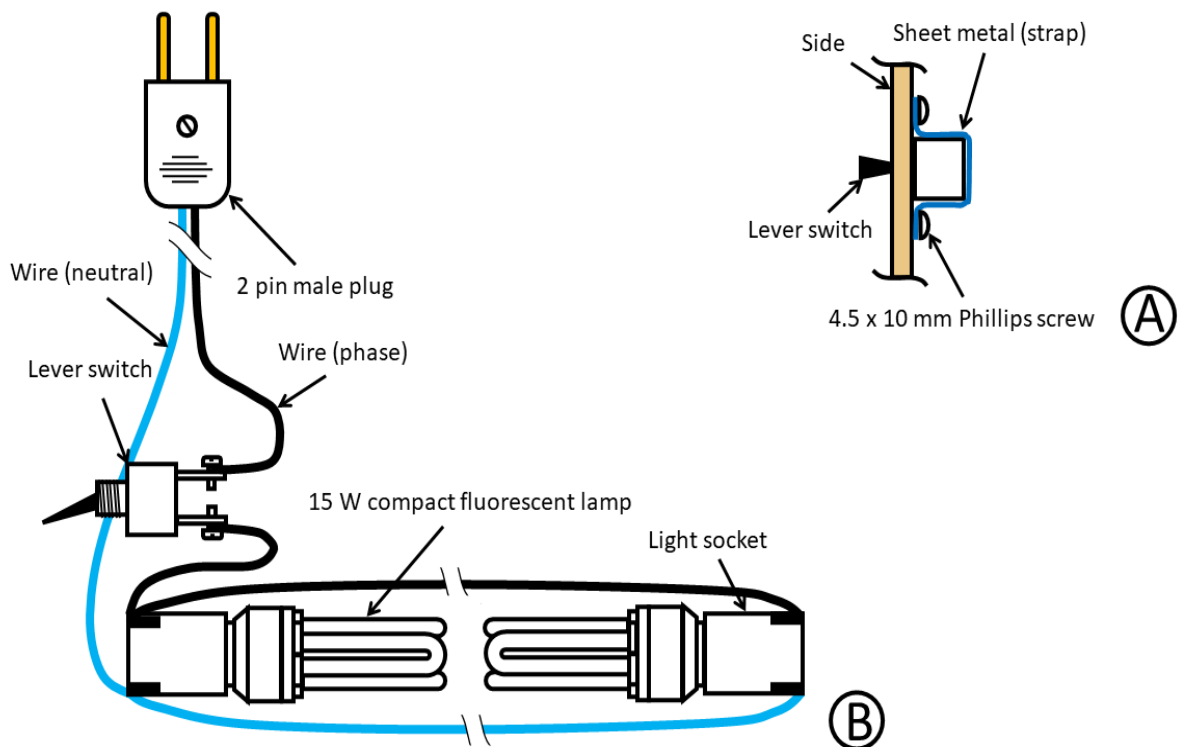


Figure 6. Schematics of the assembly of the electrical components of the light table. (A) Part of the left side, showing the switch held in place by the metal strap and the lever passing through the hole in the plywood piece. (B) Electrical installation, showing the power cord, the switch, the light sockets, and the fluorescent lamps.

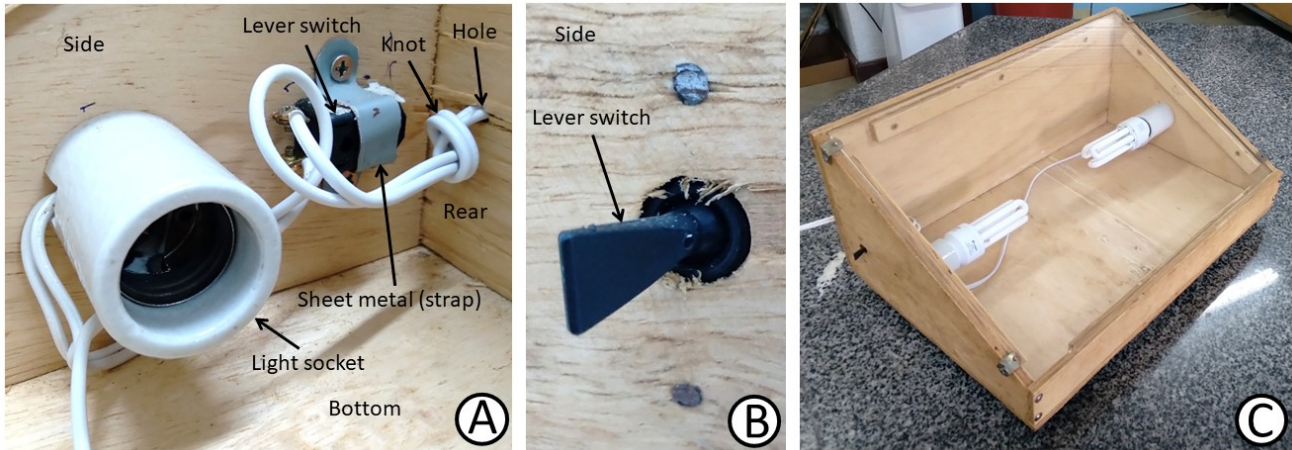


Figure 7. Photos of the assembled light table. (A) Detail of the internal face of the left side, showing the switch held by the metal strap, a light socket, and a knot made in the wire before passing through the hole in the rear of the light table. (B) Detail of the external face of the left side, showing the lever switch. (C) General view.

Although in this work a microscope image was used to create the drawing, the technique presented here can be applied to photographs taken with a stereomicroscope, telescope, or any other optical equipment.

As with any methodology, the one described here has its advantages and disadvantages.

When comparing the technique proposed here with the conventional camera lucida, we can list the following advantages:

- 1- Low cost in the manufacture and maintenance of the proposed equipment.
- 2- In many cases, the cost of acquiring photographs is zero, considering that practically everyone who deals with research currently owns a smartphone equipped with a camera.
- 3- In many cases, the cost of printing photographs is irrelevant, considering that practically all teaching and research institutions currently have at least one computer and a printer.
- 4- Greater comfort when drawing, as it can be done in any environment with electricity, and the draftsman can interrupt and return to the activity at any time.
- 5- Abolition of the need to install and uninstall a camera lucida on a microscope or stereomicroscope, thus preventing damage to the equipment.
- 6- The possibility of illustrating moving objects or objects that change over time, which would be impossible or difficult to do with a conventional camera lucida.

As for the disadvantages, we can cite:

- 1- Problems focusing on all parts of the structure to be illustrated at the time of micrograph acquisition.
- 2- Although, as already mentioned, the equipment used in the procedure may already exist in the teaching and research institution, but the institution may have limitations in owning them or in providing proper maintenance.

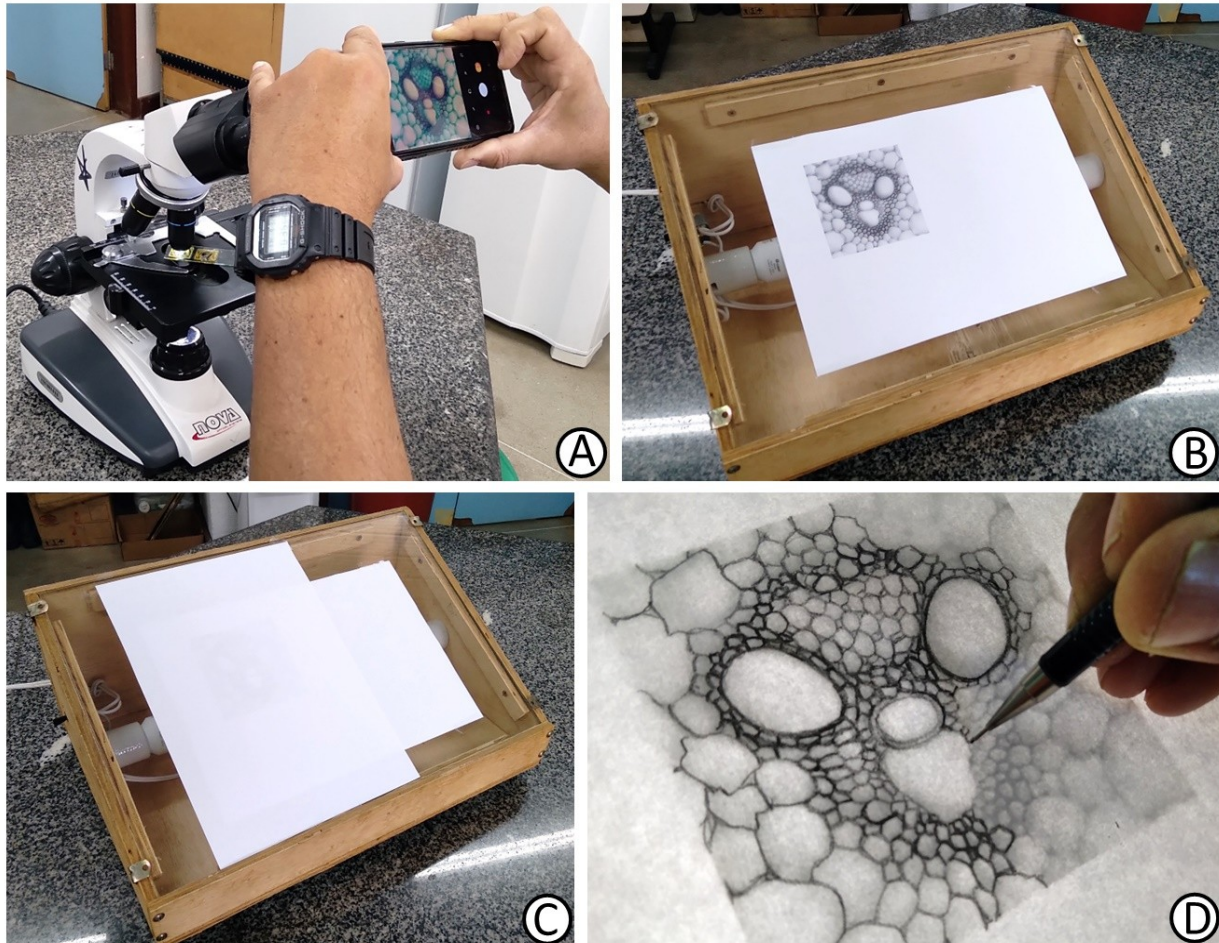


Figure 8. Photos of the procedures for drawing a grass vascular bundle according to the methodology described in this work. (A) Image acquisition from a microscope using a smartphone. (B) Printed image on an A4 paper sheet adhered to the glass of the light table. (C) Blank sheet of paper overlapping the paper sheet with the printed image. (D) Performing the drawing.

The elaboration of the present work was another initiative aimed at working with science in an optimized, economic, and accessible way (PAIVA *et al.*, 2006; LEITÃO & CORTELAZZO, 2008; LEITÃO, 2016; WU *et al.*, 2016; LEITÃO, 2018; 2020; SILVA *et al.*, 2020).

CONCLUSION

It is concluded that the methodology proposed here is low-cost, easy to perform, and has excellent results, making it an excellent alternative for the creation of drawings of structures observed under a microscope, stereomicroscope, and other optical equipment.

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