THE FOLDSCOPE: A PROMOTER OF SCIENTIFIC TEMPER OF SECONDARY STUDENTS

Abstract

The microorganisms present in our surrounding greatly affect our community. To identify these microorganisms we have to require microscopes and other sophisticated laboratory setup. But this can be easily done in spot (without going to laboratory) with the help of a foldscope, an origami portable and affordable microscope that can be carried in every student's pocket The foldscope can be used as a high-end frugal technology for teaching science in secondary level. The exposure of students to foldscope through practical demonstration of microorganisms through it could promote their scientific temper. Moreover study of microorganisms through foldscope could channel student's interest towards further projects and other original research work. This study aims to explore the foldscope in science classroom and additionally in their projects and field survey.

Keywords: foldscope, scientific temper, secondary student

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I. INTRODUCTION

In the progress of a society the education plays an important role. For the upliftment of the quality of education different educational institutes are still devoid of different latest facilities and methods of teaching. The school level is the base of building concept any invention or discovery. Learning science with only theoritical knowledge cannot be considered enough for complete vision of science. Learning science through practical sessions helps in better understanding of a concept in a particular topic and it creates student's interest towards the subject of science. However due to facility constraints, lack of proper space for constructing laboratories, unavailability of electricity, high cost of instruments, many educational institutes often face difficulty in conducting practical sessions. Hence development of portable instruments with low technical requirements for school level practical can be a noble deed. One such portable and handy instrument for studying science speacilly biology is the "Foldscope".

II. THE FOLDSCOPE

The foldscope is an origami (folding) based optical microscope (Fig.1), that can be easily assembled with flat sheet of paper affordable for mankind and the physics of optical designing and imaging. It was developed by a team led by Dr. Manu Prakash and his student Dr. Jim Cybulski from Stanford University, USA [1]. The idea of creating a low-cost microscope using simple parts struck to Manu Prakash in 2011, when he was having a scientific visit to a field station in Thailand. There, he observed that though expensive microscopes were available in the station, people seldomly used them and were afraid of or apprehended that this costly equipment might go bad or broken by their mistakes or mishandlings. It made Manu Prakash think to create a cheap, affordable and versatile device which was sturdy enough to be used in field conditions and people should not have a hitch to use it. He also thought to supply the Foldscope in form of an easy to assemble kit so that people can assemble it themselves.

The cost of foldscope is less than US$1 (~ INR Rs.70) to build and it can be easily purchased by all students. The foldscope can be taken in pocket to any place and images can be documented by taking a picture in mobile devices for which it is more advantage over microscope. It is highly useful in microscopic field study. The lens of foldscope is made of borosilicate and spherical in shape, comes in two magnification type. The lower magnification 140X lens with diameter 2.4mm provides resolution up-to 2.2 µm and higher magnification 430X with diameter 0.8mm provides resolution up to 1.44 µm with LED modules [2]. It is a part of the "frugal science" movement which aims to make high-end scientific equipment and scientific exploration accessible to the common man for scientific use in the developing world [3]. It can be assembled from a punched sheet of cardstock, a spherical glass lens, a light emitting diode and a diffuser panel, along with a watch battery that powers the LED [4]. It is capable of magnifying over 2,000 times, however because the foldscope is only in Beta testing, the microscopes sent out to global testers will only have 140 times to 480 times magnification. The Prakash Lab has created many specific foldscopes in order to detect certain diseases. In some underdeveloped countries that may not have access to microscopes, the foldscope can be a key diagnostic tool, and can therefore lead to better treatment.

1. **Assembling and handling of fold scope:** The foldscope can be easily assembled and it can be assembled within 10 minutes using manual instructions from a flat sheet of origami paper comes with an accessory toolkit including paper slides, plastic coverslips and other basic requirements (Fig.1). Adjustments can be made in all three axes, i.e. X-, Y-, and Z- axis. It requires no external power supply and has the capacity to withstand harsh environments. It is also a cost effective device with its weight almost 8.8 g and dimensions of about 70×20×2 mm^3 which can be easily assembled to a pocket sized, affordable compact microscope that can be used to explore the microbial world. The slide is inserted into the foldscope in such a way that sample side was close to lens of foldscope. A LED light supplied with foldscope instruments is used a light source The clear images under foldscope for each sample are photographed using smartphone camera by adjusting zoom and focusing of camera and foldscope. Once assembled, the Foldscope is about the size of a bookmark. It comes in a kit with multiple lenses that provide magnification from 140X to 2,000X. The kit also includes magnets that can be stuck onto the Foldscope to attach it to a smart phone, which allow the user to take pictures of the magnification [3].

2. **Foldscopic imaging procedure of bacteria:** The slides were prepared by simple staining for selected colonies. On the basis of cell wall composition to differentiate the bacteria whether it belongs to Gram positive or Gram negative, Gram's staining was done Bacterial cultures were observed to find gram negative and gram positive bacteria by performing staining at various time intervals. The slide was placed in the paper based microscope interfaced with a mobile phone. After staining the cells were observed under foldscope and recorded the images for further analysis.

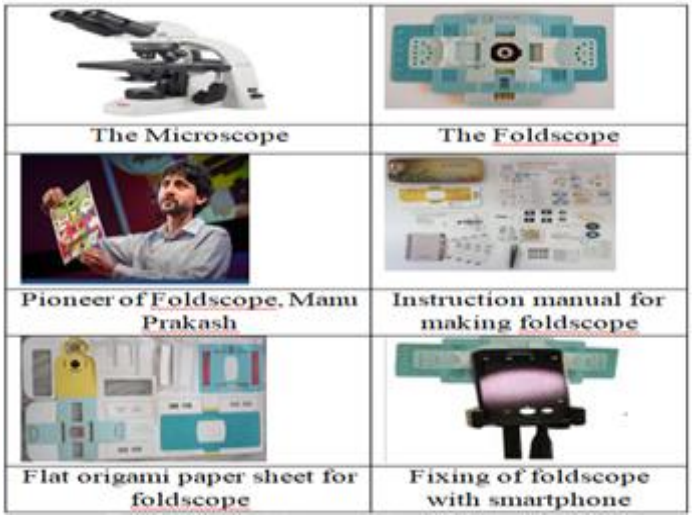

Figure 1: Assembling and handling of foldscope

3. **Foldscope as a promoter of scientific temper**: Education and Research is nowadays a term up solution that sound to resolve any impact to the well being. Adequate research and tools are now a synchronized matter of concern in this scientific world. To bring up the socio-economic development and awareness education is only the key to drive a society. To cope up with a vast of knowledge practicals rather than theory are easier to devour but is difficult in our system (India) due to lack of skilled teachers, well equipped

infrastructure and technologies [5]. In India both the private and government schools has been affected in their education process due to lack of well equipped infrastructure [6]. A recent investigation report that a new way of teaching learning procedure is equipped by online interactions, group conference and projects that develops a framed knowledge in better understanding among the students [7]. Development of technology, pedagogy, and content knowledge (TPACK) with respect to science teachers shows a managable contact among the teachers and students [8]. Mobile has also been an tremendous device in learning process that seems to provide awareness, conservation of samples and even statistical analysis [9]. Microscopic world proves to be an elevated level of interest in science. The best effort of understanding biological science is the use of lens and resolution that provides an image beyond its imagination. Students and teachers are found to be more interactive and engaged in their experiment, by the use of microscope in classrooms. Visual information provides a quick action in student's brain, helping to memorize the facts and figures. Fast learning of biological science is more motivational by hands on training, collection of samples, preparations of slides, questioning and discussions. A study in various schools in Split-Dalmatia Country reported that 53% teachers used microscope for quality teaching of biological science while the rest have a reason of insufficient availability of microscope and lack of space [10]. To defeat the problem Manu Prakash and his team invented a paper microscope- Foldscope, cost less than 1 US dollar at Stanford University, USA. The Foldscope is an ultra design origami microscope signifying the conventional microscopes, can be carried to harsh field conditions which can be affordable by schools and colleges for biological experiments [11]. This origami instrument is extensively used for the purpose of fieldwork in Sandy Hook New Jersey. Different water and sand samples were observed and images are been stored in smartphones [12]. Student positive reviews show a graceful advantage of using foldscope in government and private schools in understanding the biological experiments [13]. An interesting throw in Genetics to study the developmental stages and mutants in *Drosophila* under foldscope proves a grand success in both schools and colleges [14]. Morphological, anatomical, an characterization of fungal pathogens in tea leaves of Sikkim were also being observed [15]. Different crucial stages of the malaria parasite-*Plasmodium falciparum* were lucratively identified under the foldscope [16]. Students mind seems to be full of curiosity. Scientific temper promotes a handful understanding beyond in experiments of the subjects enhancing logic, interactions, observations and open mindness [17].

III. CONCLUSION

The foldscope instrument is affordably designed to be carried in every student's pocket. Being an effective research tool it helps mainly in the field visits to observe the samples at instant. The smart phones is an another valuable tool to fit with for storing a particular sample image. An interacting relation between the teachers and students about the images of samples has also seen. The foldscope has proved to be a valuable diagnostic and research tool for the secondary school students that lack space and expenditure. Thus foldscope is one of the best low cost microscope for promoting scientific temper among secondary level students.

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