Intertwining the Arts and Sciences to Stimulate a Creative Mind

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ABSTRACT

From the basic motion of a simple pendulum, which acts as a tool that turns a blank canvas into pure abstract art, this particular concept has been applied to science-related art to showcase its tremendous impact on scientific, psychological and educational fields. The Art and Science Program is a collaborative artistic program between the committees from the Chemical and Energy School of Engineering, UTM, and *Sekolah Tun Fatimah* (STF), with the aim of examining the impacts of the rotational motion of the pendulum which can generate mesmerizing art on blank *mahjong* papers. The outcome of the art has been influenced by various factors, such as the viscosity of the paint used, the flowrate of the paint drip, the velocity of the paint-pendulum-modelled dripper, the position of the release point, and the motion of the dripper arising from the resultant force of multiple interacting forces. By showing the interconnections between pendulum motion, gravitational force, potential and kinetic energies, and the fundamentals of fluid dynamics, artistic abstract paintings can be created from the science of mechanics. Intertwining the arts and sciences that has been the main focus of this program can garner greater appreciation, even embraced, as it results in a significant effect on the development of both creative and critical thinking among the participants and committees.

Keywords: *Art, Science, Pendulum Art, Teaching and Learning, Student, Creative Mind*

1. INTRODUCTION

The Art and Science Program is a collaborative art program between the committees from the Chemical and Energy School of Engineering, UTM, and *Sekolah Tun Fatimah* (STF). The program aims to guide KTHO'S future engineers in discovering and developing their skills and potential so that they can follow a path which suits their abilities and aspirations. As a result of such a cooperation, students who are involved have been able to express their artistic qualities and interests in the form of performances, physical work, or both. The objectives of the program are to expose STF students to the arts, to instil and enhance creativity among STF students, and to provide a platform and opportunities for students to explore and discover their potential, within the context of group creativity as the activity unfolds. In addition, it can foster a bond of fellowship between STF students as well as committee members, and provide valuable experience to the first-year students in managing programs.

The next section provides a background to one of the activities under this program, using an interesting tool in classical physics, the pendulum. A pendulum is a fixed object hung from a point so it can swing freely back and forth due to the force of gravity [1]. To produce a creative pendulum art, the students learned how to build, control and modify a pendulum. The lengths of the pendulum were designed such that each one completes a different whole number of swings per unit time. Pendulum dowsing can be used in many different ways and thus spontaneously taps the basic human ability to be drawn to what it needs. The students also applied the theories and concepts pertaining to the pendulum into an art form that can be interesting for them, while exploring the science that underpins the creation of such an art form.

In this program, the students learned about the forces of motion and gravity via a new painting technique which involved exchanging the paint brush for a swinging pendulum. When discussing the concepts with the students, the swing was chosen as the most relevant and recognizable example. As a swing moves back and forth due to the force of gravity acting upon it, the physics of a pendulum is made apparent. In addition, the pendulum swing combined with paint can result in fascinating artwork, adding value to the activity by creating new learning outcomes. When students carry out a scientific experiment without knowing the outcomes, it can lead them to learn how to solve their problems on their own. In addition, through the incorporation of a creative activity, students can also express a range of their own ideas and feelings [2]. By doing so, they can build their self-confidence and self-efficacy [3]. Therefore, this activity engages the students via the combination of art and science, which promotes creative and critical thinking that can help them become critical thinkers and successful problem solvers.

2. BACKGROUND

2.1. The Definition of Art and Pendulum Painting

Art encompass a highly diverse range of human activities engaged in creating visual, auditory, or performed artifacts. Artworks express the artist's imaginative or technical skills, and are intended to be appreciated for their beauty or emotional power. According to Kant, art can be defined as a kind of representation that is purposive in itself and, though without an end, nevertheless promotes the cultivation of the mental powers required for sociable communication [4]. Art is often examined through the interactions of the principles and elements of art. The principles of art include movement, unity, harmony, variety, balance, contrast, proportion and pattern. The elements include texture, form, space, shape, colour, value and line. The various interactions between the elements and principles of art help artists to organize sensorially pleasing works of art while also giving viewers a framework within which to analyse and discuss aesthetic ideas [5].

Pendulum painting involves a paint-filled pendulum to create unique patterns of art using the force of gravity to affect the velocity, acceleration, and the kinetic and potential energy of the drawing tool in this painting technique. The force of gravity acts upon the pendulum down towards the centre of the Earth. The momentum built up by the acceleration due to the force of gravity causes the mass to swing in the opposite direction to the direction of motion, to a height equal to its original position. This momentum can be explained by Newton's Law of Inertia, which states that an object in motion will stay in motion unless acted upon by a resultant force upon itself. Since energy can neither be created nor destroyed, its potential and kinetic energies alternate as the pendulum swings, which creates different paint patterns as the components come together as it swings [6].

The pendulum can also be regarded as a two-degree mechanical measurement device with two controls [7]. It has been applied to science-related art as an illustration of its tremendous impact on scientific, psychological and educational fields. The oscillating and rotational motion of the pendulum can generate mesmerizing art. The pendulum's physical model and the phase plane representation of the basic responses for an unforced system are depicted in Figure 1. Depending on the initial conditions and force parameters, the vertical oscillation of the pivot point results in pendulum oscillations or rotations. The closed loops indicated by digits 1 and 2 correspond to the oscillations around a hanging down position. Once a sufficient amount of energy is supplied, the pendulum can escape from the potential well as it passes the critical point described by a separatix (curve 3), and enter rotational motion regime (curves 4) [8].

The outcome of the art is influenced by various factors such as the viscosity of the paint used, the flowrate of paint drip, the velocity of the paint-pendulum modelled dripper, the positions of the release point, and the stability of the dripper from the resultant force of multiple interacting forces. By showing the connections between pendulum motion, gravitational force, potential and kinetic energies, and the fundamentals of fluid dynamics, artistic abstract paintings can be created from the science of mechanics. As Klee [9] incisively said, art does not reproduce what is visible. It makes it visible. Max Planck had declared that scientists should indeed use artistic imagination in their work. As we are entering a new era, creativity is not only becoming increasingly important, but it also seems that our future is now closely tied to human creativity [10].

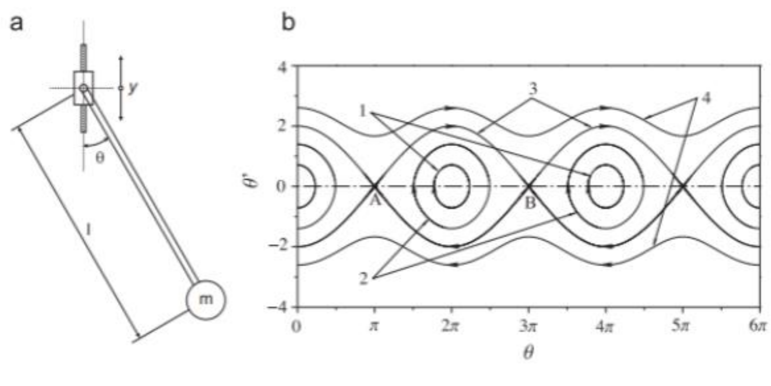

Figure 1 Physical model of a pendulum

2.2. Significance of Bringing Science and Art Together

Science and art are often considered as polar opposites of two separate subject areas [11]. Akin to water and oil, it is presumed that the two fields of knowledge cannot be integrated or mixed together. Contrary to popular belief, such claim can be proven to be no longer relevant since the world has progressed towards a new era of compulsory interdisciplinary learning. As evidence, universities are moving towards assimilating both art and science within the undergraduate curriculum via collaborative programs. For instance, at DePauw University, students from chemistry and sculpture departments were assigned to work on an art-science sculpture project [12]. Moreover, the former Minister of Education Malaysia announced in his press remark that the country is improving its system of education by bringing the arts and sciences together through a seamless school approach [13]. Therefore, it is significant that the mixing two traditionally separate fields of study is what actually drives this trend of a new approach to learning.

Surprisingly, the significance of the effects of combining the arts into science had been discussed a long time before. A group of students from different backgrounds – biological science, art, nursing and computer science – were brought together to study the brain of a zebra fish and to produce a set of digital images of it. It was said that an enormous pedagogical value had been garnered from the project which benefited the students themselves since they were able to teach one another about their own expertise. The transfer of knowledge had brought down academic barriers among the students and enhanced their social skills specific to their future profession [14]. It was mentioned that, although there is no hard evidence to support the argument that art-science partnerships would be academically beneficial, history has shown indirect proof when Jacobus Henricus van 't Hoff portrayed several highly successful scientists who were also poets, artists, or writers of fiction, including Galilei, Newton, and Faraday [12]. It is also worthy to quote Albert Einstein, “the greatest scientists are artists as well" [15].

As discussed in this paper, pendulum painting is clearly an activity that merge science and art in an interesting way. Similar to the harmonograph, the swing of the pendulum (represented by paint bottle) creates a harmonious motion, and the motion’s pathway is interpreted via a visible curvilinear painting. The resultant painting is referred as Lissajous’ pattern, named after a nineteenth-century French physicist who developed an optical method for studying vibrations. The Lissajous’ curve has been studied by many physicists and mathematicians [16]. It was also studied in the biomedical engineering field to help detect abnormalities in electroencephalography (EEG) and electrocardiography (ECG) signals [17]. Conclusively, it is believed that these kinds of activities can create a fun and interactive environment by letting children and students to explore, experience and discover.

3. METHODOLOGY/MATERIALS

Through this activity, the students conducted experiments related to pendulum colouring techniques. They were exposed to making decisions pertaining to factors that can affect their artwork, which include speed, distance and colour concentration. The different colours used in this activity enabled students to create unique and interesting artwork. The equipment used for this activity included 3 units of 500ml plastic bottles, 2 units of flask holders, cups, coloured paints, ropes, *mahjong* paper, a 4-foot-long timber rod or ruler, and plastic pads.

To conduct the experiment, 2 units of flask holders were held vertically and in parallel to hold a 4-foot-long timber rod. The rope was fastened in the centre of the rod in between the two-flask holders in order to hang a plastic bottle that has been cut in half. This is to facilitate the pouring of the paint into the bottle. Figure 2 shows the overall setup and the apparatus used in the experiment.

Students poured paint of primary colours of red, green and blue into a plastic bottle that served as a pendulum. The experiment was started when students activated the oscillating movement of the pendulum by pulling the bottle at a 45-degree angle, and then releasing the bottle when the paint had started to emerge from the bottle cap. Students conducted the experiment according to the following variables:

i. Different paint concentrations
ii. Different lengths of rope
iii. Different bottle release angles
iv. Different sizes of bottle cap hole

Various factors were taken into consideration to influence the outcome of the art. The viscosity of the paint used with the presence of CO2 played a critical role in controlling the distribution of the size and stability of the spray droplets [19]. The use of CO2 for painting is a promising technique in the painting industry to minimize Volatile Organic Compounds (VOC) emissions and energy use [19]. Moreover, the art is influenced by the flowrate of paint drip. An existing study proved that any slight changes in flow rate would affect the diameters of the paint drips [20], and thus affecting the abstract outcome of the art. The velocity of the paint-pendulum-modelled dripper also played a crucial role in the outcome of the art. The swing rate of the pendulum is determined by its length. The shorter the pendulum, the faster the swing rate thus decreasing the time period of the pendulum. This in turn causes the pendulum to move with a higher speed [21]. Conversely, the swing rate is slower when the pendulum is longer. Last but not least, to create a more abstract painting, the position of the release point for the dripper was varied, and the motion of the dripper from a combination of irregular forces created an uneven motion that resulted in unique art.

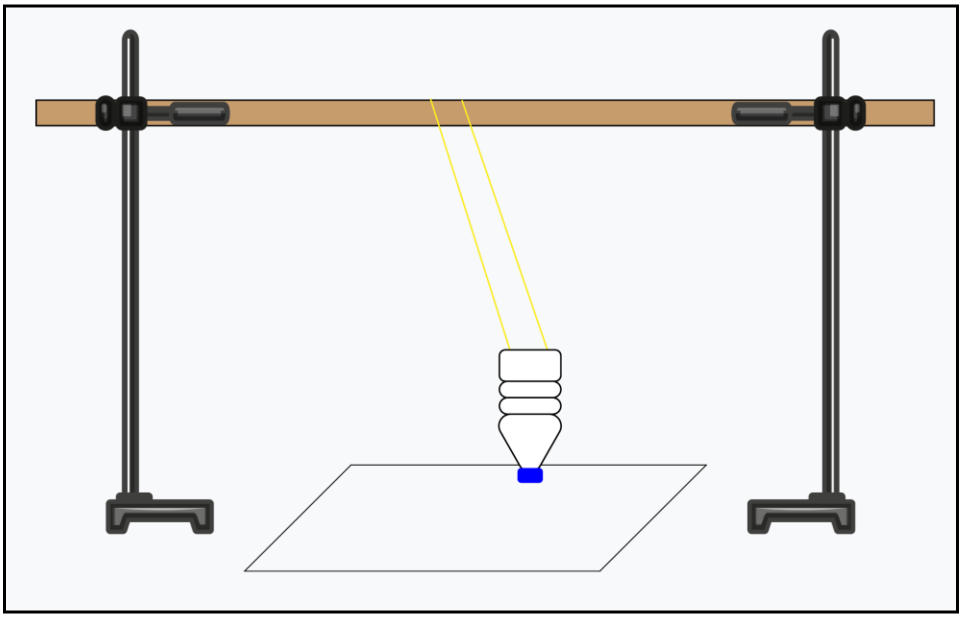

Figure 2 The setup and apparatus used to conduct the experiment

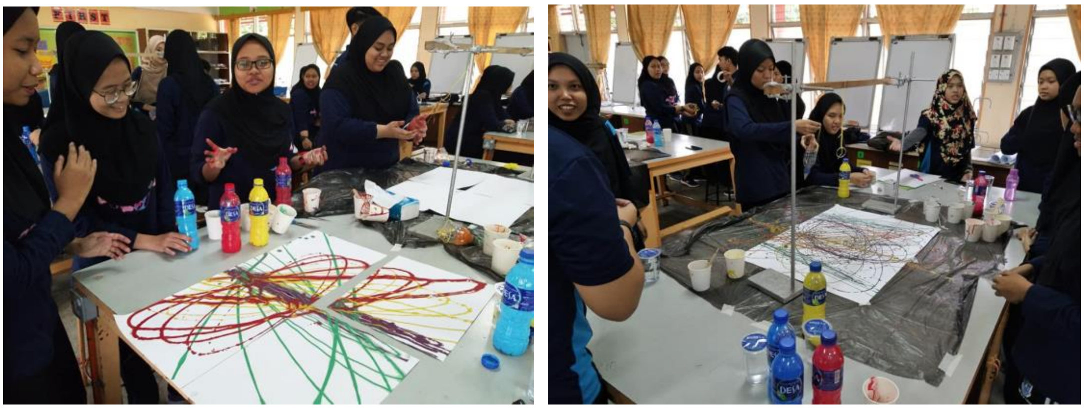

Figure 3 The students exploring art form creation via pendulum painting activities

Figure 4 The students from *Sekolah Tun Fatimah* (STF), and the Fellow and students from Kolej Tun Hussein Onn, UTM during the pendulum painting activities

Figure 5 Examples of pendulum paintings produced by the students

4. RESULTS AND FINDINGS

The combination of art and science has many benefits to student development. The implementation of science in art lessons not only engenders fun in learning, but it also helps students understand scientific concepts that may be too difficult to grasp at their level of knowledge. As a result of this program, the students managed to learn four new artistic and scientific concepts. Firstly, the students demonstrated and observed how the position and motion can be changed by pushing and pulling objects. Secondly, the students learned to design an experiment to test the effect of a force on an object, such as a push or a pull, and via gravity, friction or magnetism. Thirdly, the students were able to identify and describe the changes in the position, direction, and speed of an object when acted upon by the resultant force of a combination of irregular forces. Finally, the student discovered that there is a relationship between force, motion and energy. Concepts, hypotheses and theories pertaining to pendulum movement, gravity, potential and kinetic energy are much easier to explain via a hands-on experience for the students rather than via rote learning. Although the use of a pendulum in art lessons is a relatively simple approach, it further reinforces that the sciences can be easy to learn if it is translated into a legible and comprehensible form such as pendulum paintings. The intangible outcomes at the end of the program were also valuable. The students of STF and UTM were able to build and enhance team spirit, work collaboratively, and the most important lesson being to intertwine the arts and scientific theories to stimulate their creative thinking.

5. CONCLUSION

Integrating both the arts and sciences through such an activity can help the students express their ideas into action while leaving their comfort zone. In this way, students are not only able to explore their true potential, but also enhance their skills with problem solving, while building their character at the same time. Therefore, this can become an excellent recipe for student development. It is recommended that the activity be continued in the future, as well as to seek other ways of intertwining the arts and sciences as a stimulus for a creative mind.

ACKNOWLEDGMENT

The Art and Science Programme is supported by Kolej Tun Hussein Onn, Universiti Teknologi Malaysia.

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