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Importance And Impact Of Scientific Animations In Learning Molecular Biology By Undergraduate Students

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Abstract:
By the current study the researcher focussed on scientific animations and its importance and impact on undergraduate students. After giving the historical background in introduction section, he has depicted today's scenario regarding the approach of the students towards the subject molecular biology. When the researcher identified the knowledge gap between and noticed the complexity of the subject through which students fail to visualize the complexities and cellular procedures. Hence, it becomes challenging for teachers to teach students' cellular processes in an easy manner. Therefore, has chosen the subject molecular biology for confirming the assumptions and through specific objectives set for the current paper. The fundamental aim was to understand the importance and impact of scientific animations in learning. For measuring the impact, researcher has conducted online and offline survey method of animations, and then divided students into different groups and observed each group for their response. Finding of the study showed that animation holds considerable learning potential, and using 3D animations, one can systematically understand structural relationships of molecule.
Keywords: *scientific animations, learning style, science, molecular biology, students*

1. INTRODUCTION

Here the researcher has performed a study on scientific animations and its importance and impact on undergraduate students in learning molecular biology. Molecular biology is the central portion of modern biology that sheds light on various aspects of a living organism. The molecular biology branch studies the organism at the molecular level, including genetics. Since the second half of the twentieth century, the department increased its importance and value after discovering the DNA structure by Watson and Crick. The discovery gave birth to genetic engineering. Several biology courses have changed their unifying approach from a complete organism to the molecule or cellular base of life with the evolution of science and technology. The transition altered the process of understanding and learning that subject.

Nowadays, it becomes essential to understand the function, structure, development, and evolution of life at the cellular and molecular levels. Hence to make aware of these discoveries to students, several biology subjects are taught. Generally, every organism is made from the compartmentalization of eukaryotic cells into organelles. Entire cellular life is under the control of molecular and cellular procedures. The complexity of the structure and cellular process is challenging to understand by students. Hence, to make them know, learning institutes and universities try to implement several techniques, and scientific animations are one of them.

While learning molecular biology, students fail to visualize the complexities and cellular procedures. Hence, it becomes difficult for teachers to explain students' cellular processes in an easy, comprehensive, and understandable manner.

Computer based or scientific animations are pictorial presentations plays crucial role in resolving complicated learning challenges. In other words, these are stimulated motion pictures presented along with movement of objects to explain the concept. With the development of computer-aided learning, scientific animations become more popular and elegant learning tools to support learner of any age group. Animation based learning uses

potential graphics, images, colored tools to explain and clarify the concept in detail. Here, in the present paper, researcher tried to explain the importance and role of scientific animations in understanding various concepts in molecular biology. Also, researcher selected the molecular biology subject considering the complexity of the subject.

1.1 Purpose of the study / objectives of the study

The researcher has performed present study with the purpose to understand the importance and impact of scientific animations in learning molecular biology by undergraduate students. For attaining the purpose of the research, the research student has formed several research objectives as –

i. To understand the importance of graphics, visualization, and animation in learning
ii. To understand the role and impact of visualization in biology class
iii. To understand the use of scientific animations in explaining molecular biology
iv. To understand the value of scientific animations in improving students learning

1.2 Importance of the study

All the information obtained through the present study will help all students and teachers in teaching and learning molecular biology. The research study pertains to information to bring positive outcomes and improve undergraduate students' understanding of molecular biology concepts. Computer animations and visual effects help undergraduate students effectively and lead to improved understanding.

Here the researcher has selected molecular biology subject because teaching that subject is difficult. It involves range of procedures happening on cellular or molecular level. Many times, teachers have only access to 2D tools to teach and explain the subject, but for obtaining clear understanding it is essential to have four dimensional structures. Further, based on reviewed literature, the researcher observed that visualizing those molecular happenings in 3 dimensions supports understanding and makes learning effective. Also, it helps in understanding concepts for long time.

1.3 Definition of Terms

Animation

1. Animation is the rapid display of a sequence of images to create an illusion of movement. [1]
2. Animation is a basically a pictorial presentation and become prominent feature of technology-based learning environment. [2]
3. Animation is a stimulated motion pictures shows movement of drawn objects. [3]
4. According to Mayer and Moreno (2002) animation is a form of pictorial presentation - a definition which also refers to computergenerated motion pictures showing associations between drawn figures. [4]
5. Animation is displaying a sequence of pictures sorted in time. This includes all possible changes causing visual effects (position, shape, color, transparency, object structure and its texture, light, camera parameters, and even rendering technique).[5]

Definition of computer animation

1. According to Halas and Manwell 1968, a definition of computer animation is a technique where the illusion of movement is produced by displaying them on a screen, or recording on a recording device a series of individual states of a dynamic scene. [6]

Definition of molecular biology

Molecular biology is the biology branch that deals with the molecule level basics of biological entity and cells. It involves the study of molecular synthesis, molecular modifications, activities, interactions, and mechanisms. [7] [8]

2. REVIEW OF LITERATURE

The animation is the pictorial form of representation and came into existence as a counterpart to verbal forms of teaching. [9] Also, verbal ways of presentation have a long effect on education and visual forms of presentation. The animation is an effective way to tackle difficulties that arise while presenting complex matters verbally or numerically.

Multimedia instructions using animation holds a high potential to enhance students learning. [10] As Hegarty (2005) stated in Learning with Animation: Research Implications for Design, “the current emphasis on ways of improving animations implicitly assumes a bottom-up model animation comprehension. Here, comprehension is primarily a process of encoding the information in the external display, so that improving that display necessarily improves understanding.” [11]

Several studies carried out to obtain an effective way to improve students' understanding and clarification of the molecular biology concept. According to research performed by Marbach-Ad and Stavy 2000; Templin and Fetters 2002, teaching and learning molecular biology were regarded as the toughest task. [12]Further, Gilbert et al. 2003 on molecular genetics suggest that it is essential to enhance molecular genetics teaching through

educational methods using integrated modelling and visualization. [13]More specifically, NSF2001 suggests that visualization tools like animations can provide a precise and rich picture of the molecules and molecular interaction. They are challenging to understand by using text-based presentations and information. [14]

The use of animations in teaching has expanded, and various animations are now entering into learning sector to enhance the pace of concept clarification. Scientific animations in molecular biology have many benefits such as simplifications, unlimited resolutions, magnifications, highlight specific points, symbols within the complex background. Also, animation offers the facility to control motion, colour change, fading effects, and many others. Apart from this, Williamson and Abraham performed a study in 1995, where he explored the role of computer animations on college chemistry students. [15] During the investigation, he found that instruction with animations may increase conceptual understanding by promoting dynamic mental models of matter's particulate nature. During such education, scientific animations offer precise and correct visual models for sub-microscopic processes.

Gordin and Pea (1995) showed that the main advantage of the use of computers for instruction is a phenomena involves a sequence of animation, combining a temporal component; as it holds the opportunity to manipulate data sets and test the result of the manipulation (Windschitl 1998), and increases students' motivation. [16] [17]

Matray and Proulx (1995) declared that animated software could show and interpret biological concepts more precisely than traditional ways like lectures, discussions, or conventional laboratory activities. [18]

Several studies were performed regarding using animation effectively to make the learning interactive and enhance student involvement in learning science. Further, research states that animation models and other visual impacts are an engaging way to enhance students' learning. Based on the study performed by Sewell et al. 1995; Windschitl 1998, Computer animations incorporated into interactive simulations can offer the user a chance to manipulate variables to observe the effect on the system's behavior. [19]

Further, Berenfeld et al. 2004 showed that when students work with the models, they remember concepts and transfer their learning to new situations. [20] Here, the researcher has found that computational animations and graphics have acquired large space in molecular biology nowadays. Besides, computer programs support genetics at the macro level.The researcher has selected molecular biology subject in the present paper as it involves many structural formations, regulations, and actions related to cells. In 1930 established the branch of Molecular biology. The term molecular biology was coined by Warren Weaver. [21] Further, molecular biology involves the study of genetic mechanisms, structural study and modifications of the gene. Hence, for obtaining a precise understanding of those molecular changes and modifications, it is essential to have proper animation or structural presentation.

Research Methodology

3.1 Research overview

In the present study, the researcher aimed to acquire answers to various research objectives. Here, the fundamental aim was to understand the importance and impact of scientific animations in learning molecular biology by undergraduate students. For the present study, the researcher has characterized the learning that occurs due to visualization and scientific animations by collecting data on the learning process.

3.2 Participants

For the present study, the researcher has selected undergraduate students learning molecular biology.

3.3 Materials and Measures

Here, the researcher has studied the already prepared animations for molecular biology. To measure the impact of animations, the researcher divided students into different groups; observed each group for their response.

3.4 Procedure

Here, to reach the research goals, the researcher has selected the online and offline survey method.Also, the researcher has observed available research papers to obtain research goals. The fundamental aim of the study is to understand the impact of animation in understandingmolecular biology.The researcher has conducted the study by considering the graduate students trying to understand molecular biology concepts for the study purpose.

3.4 Data analysis

The survey method of research involves various procedures, including survey performance, sample selection, and survey implementation, data analysis, and results. Here, each step depends upon the collected data. Here, the researcher has performed a detailed analysis based on collected data and provided the results below. Before performing analysis, the researcher has prepared an analysis plan based on the topic and objectives of the study.

Here, data was then analysed using qualitative method of analysis to get results. Here, in the present study, researcher has used various techniques including multiple regression analysis, Analysis of variance.

Multiple Regression Analysis

It is a set of procedures to study the straight-line relationships within two and more variables. Multiple regressionshelp to determine the β's in the equation

$$yj = \beta 0 + \beta i\ x1j + \beta 2\ x2j + \ldots..+ \beta p\ xpj+ \varepsilon j \text{ [22]}$$

Where,
X is the independent variables,
Y is the dependent variable,
Subscript j represents the observation (row) number,
β's are the unknown regression coefficients,
β represents the original unknown (population) parameter,
b is an estimate of this β,
εj is the error (residual) of observation j.

3. FINDING

4.1 Graphics, visualization, and animation are important in learningmolecular biology

Here, the researcher has performed a study to understand the importance of graphics, visualization, and animation in learning. To understand the value of graphics in learning, the researcher reviewed more data and observed research data drawn by Paivio, 1979,1991. Here, Paivio stated theory of the dual-coding which suggests that long-term memory retention is facilitated by a combining verbal and visual cues. [23] Here, animations create visual impacts and support long-term memory.

While performing the literature review, the researcher observed that visual perception is the most developed sense in humans and decides the way we learn.[24]. Further, the researcher observed data that denotes vision enables collection and processing of information from the environment and takes decisions or formulates concepts based on that information. In short, visualization supports students in understanding concepts, procedures easily. Further, the researcher went across data presented by Kraidy, 2002, Linn et al., 1996, where he observed that well-designed visual tools support students in digesting large amounts of information in a short time and construct their personal visualization of a process. [25]

Specifically, computer animation is the latest educational tool that supports long-term learning by capturing attention to objects during initial instruction steps. [26] Further, Rieber, 1994 demonstrated the use of animation to convey ideas and processes that reduce associated abstractions with transitions of the process with time.

After reviewing the literature, the researcher observed that motion animation produces differences with still images and offers a smooth transition that captures the critical interrelationships along a specific process path. Further, motion animation supports establishing long-term memory, which is not possible with static images. [27]

Research studies performed so far shows that student learns more effectively from animations compared to static images. The further research outcome of Paivio, 1979, 1991 shows that comprehensive learning is achieved by combining animation with a lecture. Such combination provides a reference from which students can appreciate the knowledge presented in the animation. [28]

4.2 Scientific animations are essential in explaining molecular biology

Here, in the present study, the researcher observed that animation holds high value in learning various subjects, most specifically molecular biology. Accurate animation with static illustration increases the pace of learning and understanding. Animation in cell biology helps students in obtaining clarifications on molecular biology.

Molecular biology involves the study of protein structures and the study of several enzymes and their actions. For students, understanding their activities and structures becomes difficult, and here, scientific animations work well. Specifically, computer animation programs like Chime and Kinemage are the tools that allow students to rotate the protein or enzyme structure and observe them from different angles.

Animation holds considerable learning potential and act as a part of computer-generated visualization. Here, in learning molecular biology, use of animation can clarifies the information to students. Through animations students can rotate computer-generated molecular model to understand their arrangement in more detailed manner. Also, using 3D animations, one can systematically understand structural relationships of molecule. Additionally, researcher has observed that scientific animations help students to understand the dynamics of every single molecule and their interactions.

4.3Visualization plays crucial role in biology class

To enhance and support scientific learning, visualization is a valuable tool, as suggested by Gordin and Pea, 1995. [29] According to Brodie et al., 1992, visualization help learner with essential concepts. [30]Further, based on the study performed by NSF2001, researcher come to know that animation is a visual tool that offers precise and rich presentation of the activities happening at molecular level. Also, it gives insights on molecular interactions and modification to its viewer. Further, researcher observed that understanding those concepts were challenge for students, but then using animations, students received proper clarification on even complex structures.[31]

With the development of technology and internet-based learning tools, teachers started using several visualization tools while explaining concepts in the classroom. Using a conventional method that involves using

a blackboard can explain the structure and related molecular processes. But this approach does not help obtain knowledge about the orientation and activity of every molecule. In conventional chalkboard teaching, the teacher uses to draw various illustration on the board. Here, many lines and arrows occupy most of the space on board but fail to clarify student's majority of times.

During reviewing literature, researcher observed that the visual system is a potential educational tool and offers benefits to learners. In molecular biology visualization is designed to represent arrangement of atom, molecule, carbon, oxygen, etc. Here, the fundamental aim behind using visuals is to make students understand about the actual concept. The researcher has observed that visuals support students in learning new concepts.

4.4 Scientific animations are valuable in improving students learning

During research study, the researcher has observed that scientific and computer animations offer the next level of learning sophistication. Using animations, one can explain step-by-step procedures in a detailed manner. Also, it becomes possible to understand the structural detailing of every molecule for learner and teacher. It is easy to go forward or backwards in animations to make a clear understanding of the concept to a student. Animation offers clear illustrations through transitions and makes learning effective through specific visual impact. During transitions, the learner captures the objects and shifts focus on every object and components. Additionally, sound, visual effects, and animations help undergraduate students learn molecular biology by revealing every object detailing. Besides, considering the complexity of the subject, animations help students understand the processes and interaction of molecules.

Additionally, the storyboard works as a helpful guide for animation artists while working with Maya software to develop animation. The animations produced using Maya are high-quality and requires about 200 hours to complete. While performing the literature review, the research student observed one research performed by Liao 1999. In that research finding, he suggested that as a whole, student learning is more significant when a multimedia learning tool is included during instruction relative to a control group without such tools. [32] Further, to understand the use of one or more multimedia platforms to boost learning in students, Mayer and Moreno performed research in 2002. Here, they suggested that one multimedia option is better to support student learning than another has been inconclusive. [33]

A research study performed by Hede 2002 states that visual input, such as animation, is a vital element that draws the viewer's attention to a topic. As a result, visual effects work as a stimulus to transfer the content into working memory. His research studies also suggest that narration has the same effect as animation. [34] Further, to understand animation's impact in improving student learning, the researcher has reviewed research performed by Mayer and Moreno, 2002. Here, the researcher observed that seven animation design principles support learning.

4. DISCUSSION

The present study performed supports the usage of scientific animations in learning molecular biology by undergraduate students. Here, the researcher found that animation work as a tool to provide instructions. However, the role of animations in improving the learning process holds several limitations. One of the limitations is that scientific or computer animations require high cost and time as well. Currently, many animations are available online that are free of cost, and the only need is to change them according to the student age group and level of understanding.

5. INTERPRETATION OF THE RESEARCH

Scientific animations are extensively used to enhance the learning of molecular biology concepts in undergraduate students. After performing the in-depth study, the researcher has observed that many students fail to understand concepts in detail. Further, the researcher has observed that explaining molecular biology concepts through animation does not require any conventional thing. Simply using images, movements, and simulations, one can explain concepts. Additionally, the researcher observed that the use of animation has the strong impact on technical elements like electricity, content, and surrounding. Several animations disturb students, and it is teachers' responsibility to use the correct type of animations while clarifying molecular biology concepts. Animation helps improve motivation, delivers the right content to students, improves attention, and supports understanding with increased curiosity.

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