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Effectiveness Of App Based Teaching For Biomechanics In Undergraduate Physiotherapy Students

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Abstract
Background & objectives: the purpose of the study was to find the effectiveness of app-based teaching for biomechanics in undergraduate physiotherapy students and classroom teaching for biomechanics in undergraduate physiotherapy students.
Method: this was a quasi-experimental study design which includes 74 subjects with undergraduate physiotherapy students were randomly allocated into 2 groups using convenience sampling. In group a (n=37) subjects were taught on app based teaching whereas group b (n=37) received classroom teaching. After analysed the participants groups were divided into group a (n=37) and group b (n=34). Students were scheduled twice a week for an hour to each group for 16 weeks. The outcome measures were measured using validated pre-prepared questionnaire and feedback form using likert's scale.
Results: the independent t-test was employed to assess the mean difference and variances between pre and post-test scores. Statistical analysis indicated there was significant difference between the groups. App based teaching was more effective in biomechanics than traditional teaching on improvement of knowledge among physiotherapy 2nd year students.
Conclusion: the findings of the study suggest that both the groups taught through an app and traditional classroom instruction showed notable enhancements in understanding towards biomechanics. However, the app-based teaching group showed superior effectiveness compared to the classroom teaching group.
Keywords:*Undergraduate Physiotherapy Students, App based teaching, Traditional Teaching, Pre-Prepared Questionnaire and Likert's Scale.*

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I. Introduction

Human biomechanics represents an understanding of how human bodies function as machines, and how they handle all of body stresses and strains. It examines the root causes of "component failure" or injury.[1] Biomechanics has been recognized to be one of the fundamental principles of Physiotherapy practice, with the objective of providing ideal care and improving movement performance; minimizing movement impairment; and intervening in movement-related injuries or disorders. [2]

Given that biomechanical concepts play a role in Physiotherapy practice, it is critical to comprehend and possess a working understanding of biomechanics. [3]The concern's emphasis has been selected to be mobility and mobility impairment, as it is one of the topics where biomechanics and Physiotherapy are most closely related. [4]

Biomechanics is often studied using two methods. One approach is to use simplified methods of measurement and analysis to offer simple yet significant aim details that can ultimately be used by the clinician or practitioner. Another approach is used for more sophisticated tools and methods may be utilized to gather precise structural and functional data by measuring or inferring loads on the musculoskeletal system. [5, 6]

The diagnosis and treatment of several pathologic disorders, the assessment of joint function, the development of therapeutic regimens for the treatment of joint issues, and the procedures for planning reconstructive surgeries are all made easier with a more thorough understanding of biomechanics. As a problem-solver, the Physiotherapist supports the patient with the correct movement patterns, and these correct patient's movement patterns will be seen by the application of biomechanics. [7]

Conventional teaching, often known as traditional teaching, is a type of instruction that involves teachers and students engaging face-to-face in a classroom setting. These professors lead class discussions and concentrate only on mastering material from textbooks and notes. [8]

Passively taking in the knowledge, students then review what they have already learned for the exams. Traditional methods of instruction could make it harder to think more creatively. Students' comprehension levels and the amount of time needed to fully learn a subject may vary. [9] Biomechanics, which is usually taught using textbooks and PowerPoint slides, is frequently utilized as a display projection during class. [10]

Although traditional method has its advantages, understanding dynamic human movement is still made easier by a two-dimensional surface and verbal descriptions are supported by musculoskeletal models and diagrams in the textbook. [11] It has been acknowledged that the core of professional Physiotherapy involves learning and imparting human movement. It is yet known how studying and teaching human movement in the context of physiotherapy could have a deeper meaning which may be limited to the profession. [12]

As a result, greater research is needed to identify what renders the process of learning and instructing human motion in Physiotherapy unique, as well as how Physiotherapy students, therapists, and instructors perceive the subject. [13] Smart technology and applications have additionally greatly contributed to recent developments in biomechanics, especially the ability to do a biomechanical evaluation without the need for expensive laboratory apparatus. [14]

To the increasing usage of Smartphone's and tablets that come with several video camera features, practitioners may now capture a variety of kinematic and kinetic outputs. [15] In addition to the conventional educational environment, students of this generation often use the Internet as a tool for studying and learning. [16] The reality that learning technology is both beneficial and enjoyable helps students adopt it in their studies. E-learning is becoming more exciting and captivating thanks to technology. As a result, it is simple to get students involved in the virtual classroom.

Each student would be given an opportunity to contribute personally to the group project in class, so expanding the amount of knowledge that is shared. By providing instructional information, frequently online, outside of the classroom, flipped learning is a sort of blended synchronous e-learning technique that flips the typical learning setting. [17]

Additionally, it is an interactive learning method. It incorporates activities inside the classroom, including those that might have previously been regarded as homework. Here, the actual didactic lecture time is devoted to putting the principles learned into practice by utilizing active learning techniques, which raises student accomplishment. Flipped learning can substitute for traditional classroom education when materials are accessible, but there are additional limitations on time.[18]

It enables the faculty to interact with students both within and outside of the classroom and to make use of a variety of contemporary technological tools. This could work well in medical and allied health contexts when staff and student clinical responsibilities make it difficult to fit in all of the material on the extensive curriculum. Flipped classroom learning may be a desirable option in the context of the current COVID-19 pandemic, where social disconnection becomes becoming increasingly common and virtual teaching-learning platforms are required more than ever. [19]

In this study, flipped classroom instruction was employed to help students better conceptualize and visualize challenging subjects like gait kinematics and kinematics. [20] With the help of a variety of accessible applications and smart devices, professionals are able to obtain reliable and precise biomechanical data while conserving both money and time. According to recent studies, smart devices and software can practically deliver reliable and precise findings in real time.

The Human Atlas, KinematicLab, OpenSim, Muscle, and Motion, as well as more advanced tools that have been demonstrated to offer some accurate and reliable information on human motions, are examples of these outputs that use basic built-in resources.[21] For the opportunity to further develop their comprehension of human anatomy and biomechanics, health science students and professionals can use the subscription-based Visible Body Human Anatomy Atlas (HAA). Numerous 3D models of gross anatomy, kinesiology, microanatomy, simulations of cadaver labs and comparisons to diagnostic imaging, tests, and patient education films are offered in this application.

Visible Body Human Anatomy Atlas (HAA) serves as a comprehensive learning tool, when a structure is selected, the app offers information such as its correct pronunciation, blood supply, innervations, muscle attachments, and animation of movement. [22] The usage of mobile learning (m-learning) in education has significantly increased as a result of the rapidly advancing technology in our society. Utilizing mobile

applications' potential to enhance education is important. Numerous Smartphone applications have been developed to aid physiotherapy students in understanding biomechanics. [23]

The kinetic or kinematic parameters based on the analysis of movement through video or photography is a resource that has frequently been used since the 1980s within the so-called Video-Based Laboratory (VBL), whose complexity has increased in line with the progress in technology. [13]The educational use of those laboratory videos has traditionally required the use, at least, of a camera and a laptop computer with software which makes analysis possible. [24]

Biomechanics, which studies biological systems using methods of mechanics, has made use of these movement analysis tools with the aim of achieving improvements in execution and performance techniques. The incorporation of applications which are useful to analyze kinematic training control variables which permit video analysis and the obtainment of training data from virtually.

The aim of the present work is thus to evaluate the impact of the use of a series of applications (called Human Atlas from Visible body) as a learning resource in biomechanics applied to physical activity, on a series of attitudinal variables (interest, motivation, applicability and learning experience). Secondly, the effect of these applications on students' learning of general conceptual contents about mechanical physics is also evaluated. [25]

Additionally, the technology offers PT students the chance to interact with the material in a manner that traditional biomechanics methods of instruction can't, including being able to examine joint movement, muscle attachments and movements, and neurovascular connections. Instructors can extract the value of conventional teaching modes and complement this knowledge in online contexts by incorporating apps into the curriculum design. [26]

Given their worth, the challenge for instructors becomes choosing which app matches students' requirements and includes features that encourage the greatest possible education. Individual concentric muscle movements can be separated and observed in the app from various perspectives, which is particularly important for PT education. The stretching and shortening of the muscle with joint movement are depicted using sophisticated animation.

Visualizing this is crucial for PT students because movement analysis is a key component of their curriculum. The capacity to see movement at the articular surfaces of the bones, or arthrokinematics joint motion, which forms the basis of physical therapy interventions, comes first. Second, while the app can display individual joint motions. [27]

The purpose of this study is to determine if teaching biomechanics to physiotherapy students using the Human Atlas App leads to more understanding and learning than conventional classroom education.

II. Materials And Methods:

Study design: quasi-experimental study design.

Ethical clearance and informed consent: the study protocol was approved by the ethical committee of gsl medical college & general hospital (annexure-i), the investigator explained the purpose of the study and gave the student information sheet. The participants were requested to provide their consent to participate in the study (annexure-ii). All the participants signed the informed consent and the rights of the included participants have been secured.

Study population: the study subjects of bachelor of physiotherapy 2nd year pursuing students were included.

Study setting: the study was conducted at gsl smart lab & gsl physiotherapy institutions, rajamahendravaram, andhra pradesh, india.

Study duration: the study was conducted for a period of one year.

Teaching duration: a total of 16 weeks, one hour for each, weekly twice.

Study sampling method: convenience sampling.

Sample size: a total of 100 subjects were screened in that 74 subjects, who are pursuing bpt 2nd year students who were also willing to participate in the study were included in this study, all the recruited participants were explained about the purpose study and relevance of the study. After obtaining informed consent form and meeting the criteria, total 74 subjects were allocated into two groups equally with 37 subjects in human atlas app group and 37 subjects in the traditional teaching group. The study was hospital based quasi experimental study design.

Group A–taught using human atlas app.

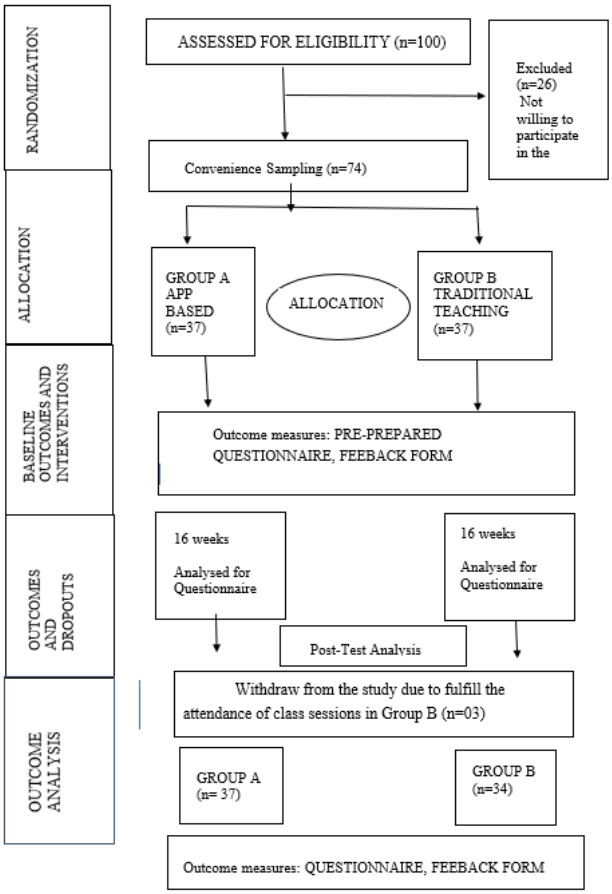
Group B –taught using classroom teaching.

Materials Used

1. Data Collection Forms
2. Human Atlas Application (HAA)
3. Samsung Smart Board
4. Google Forms

5. Validated Pre-Prepared Questionnaire
6. Power Point Presentation
7. Feedback Form

FLOWCHART



PROCEDURE: The study underwent Hospital Based Quasi-Experimental Design where it would follow 16-weeks protocol and recruits participants based on inclusive criteria. From an initial pool of 100 subjects, 74 individuals were selected as they meet the inclusive criteria. These participants are divided into two groups: Group A, consisting of 37 participants, and Group B, with 37.

After analysed Group A participants has 37 while Group B has 34 participants. The study started by conduction with a pre-test using a validated questionnaire to assess subjects' knowledge and interest levels.

Group A was exposed to app-based teaching, followed by a post-test using the same questionnaire to evaluate any changes in knowledge and interest. Conversely, Group B receives traditional teaching methods, undergoing similar pre-test and post-test procedures. The resulting data are analysed to draw conclusions. As per the expert's suggestion the shoulder complex (SC) consists of 9 hours and Hip complex (HC) consists of 7 hours of lecture time which will be covered within 16 weeks. Each week, one class will be taken for each group for one hour.

GROUP A- APP BASED TEACHING

An educational resource Visible Body Human Anatomy Atlas (HAA) helps physicians and health science students expand and improve their understanding of human anatomy, physiology, kinesiology etc. 32 The Human Atlas app proves invaluable in biomechanics for physiotherapy, offering a comprehensive digital resource. The app provides interactive visuals, allowing professionals to visualize biomechanical principles in real-time, enhancing their ability to assess and plan effective interventions. 33 The app has an innovative learning technique, where it could prove that visual memory. 34

Fig 5: Students Practicing On Human Atlas App For Group A

This study focused on comparing two teaching methods: App-based teaching and Traditional Teaching, among second-year undergraduate Physiotherapy students from GSL College of Physiotherapy & Swatantra Institute of Physiotherapy& Rehabilitation. After analysed Group A participants has 37. A pre-test using validated questionnaire were administered then Group A underwent App-based teaching using the Human Atlas App for 16 weeks, covering topics like Biomechanics of Shoulder Complex (SC) and Biomechanics of Hip Complex (HC).

The Table of the Content:

Biomechanics Of Shoulder Complex (9 Hours)

S.NO	TOPICS	NO OF HOURS
1.	Shoulder Complex – a. Sternoclavicular Joint (STC)	1 Hour
2.	Shoulder Complex – b. Acromioclavicular Joint (AC)	1 Hour
3.	Shoulder Complex- c. Scapulothoracic Joint (SC)	1 Hour
4.	Shoulder Complex- d. Glenohumeral Joint (GH)	1 Hour
5.	Shoulder Complex – e. Dynamic stabilization	½ an hour
6.	Shoulder Complex- f. Static Stabilization	½ an hour
7.	Shoulder Complex- g. Angle of Inclination	½ an hour
8.	Shoulder Complex h. Angle of Torsion	½ an hour
9.	Shoulder Complex- i. Kinematics of the joint	1 Hour
10.	Shoulder Complex- j. Muscles of Shoulder Complex (kinetics)	1 Hour
11.	Shoulder Complex – k. Scapulohumeral Rhythm	½ an hour
12.	Shoulder Complex – l. Basic Mechanics of the joint	½ an hour

Table 1: Topics Taught For The Partcipants On Shoulder Complex

Biomechanics Of Hip Complex (7 Hours)

S.NO	TOPICS	NO OF HOURS
1.	Hip Complex – a. Structure of the hip joint and pelvis	1 Hour
2.	Hip Complex – b. Lumbar Pelvic rhythm & Pelvifemoral Rhythm	1 Hour
3.	Hip Complex – c. Musculature around Pelvis	½ an hour
3.	Hip Complex – d. Movements at Pelvis (Tilts)	1 Hour
4.	Hip Complex – e. Structural adaptations of weight bearing at Femur	1 Hour

5.	Hip Complex - f. Structure and function of the trabecular systems of pelvis and femur	1 Hour
6.	Hip Complex – g. Angle of inclination & Angle of Torsion	1 Hour
7.	Hip Complex – h. Kinematics of the hip joint	1 Hour
8.	Hip Complex – i. Muscles of Hip Complex	1 Hour
9.	Hip Complex – j. Unilateral and Bilateral Stance	1 Hour
10.	Hip Complex – k. Pathologies like Coxa Vara and Coxa Valga	½ an hour

Fig 6: Demonstrating On Human Atlas App For Group A

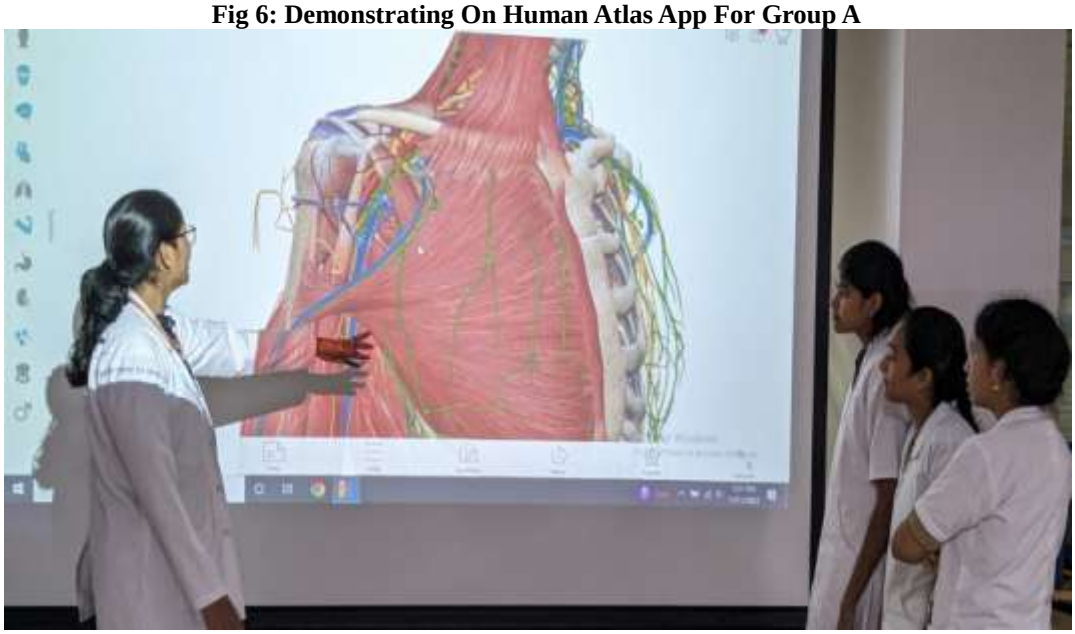


Fig 7: Demonstrating Contents Of Shoulder Complex Using Human Atlas App For Group A

Fig 8: Conducting Pre-Test For Group A

GROUP B - TRADITIONAL TEACHING

Group B was exposed to Traditional Teaching in which (37 participants), pre-test was conducted using validated questionnaire were administered. 16 weeks, covering topics like Biomechanics of Shoulder Complex (SC) and Biomechanics of Hip Complex (HC). Each week, one-hour classes were conducted. Post-tests using validated questionnaires were administered to assess the effectiveness of the teaching methods.

Biomechanics implies a foundational aspect of physiotherapy education, providing students with a comprehensive understanding of how the human body moves and functions. Traditionally, biomechanics teaching for physiotherapy students involves a combination of theoretical knowledge and practical applications. In the classroom, students delve into the principles of biomechanics, studying topics such as kinematics, kinetics, and anatomical mechanics.

Fig 9 : Classroom Teaching Of Biomechanics For Group B

Theoretical concepts are reinforced through the study of real-life case studies and clinical examples, helping students bridge the gap between theory and practice. 35 These sessions also emphasize the importance of accurate data collection and interpretation, essential skills for physiotherapists working to improve patients' mobility and function. 36

Group B (37 participants). Employing a cross-over design, a pre-test using validated questionnaire were administered then Group B underwent Traditional teaching of Biomechanics for 16 weeks, covering topics like Biomechanics of Shoulder Complex (SC) and Biomechanics of Hip Complex (HC). Each week, one-hour classes were conducted. Post-tests using validated questionnaires were administered to assess the effectiveness of the teaching methods.

Fig 10: Demonstrating Of Shoulder Complex By Using Classroom Teaching Method For Group B

Fig 11: Demonstrating Hip Complex Using Classroom Teaching For Group B

Fig 12: Demonstrating Biomechnaics Of Hip Using Classroom Teaching For Group B

To address ethical concerns, a crossover in teaching methods is implemented, with Group B instructed using App based teaching, while Group A is taught through the traditional class room teaching, ensuring equitable exposure to both methodologies.

III. Discussion:

The aim of this study was to evaluate the efficacy of app-based teaching compared to traditional teaching methods using validated questionnaires and checklists to assess the knowledge and interest levels of undergraduate physiotherapy students. This study was Hospital Based Quasi Experimental Study. The study focused on examining the subjects' knowledge and interest in app usage. The outcome measures included validated questionnaires to and checklists assess scores.

The advancement of technology has revolutionized the teaching of medical subjects, presenting a boon for educators seeking innovative methods to engage undergraduate physiotherapy students in learning biomechanics techniques. Integrated learning of theory has emerged as a pivotal approach in this endeavor. By leveraging cutting-edge teaching tools and strategies, instructors are able to make the study of biomechanics not only informative but also captivating for students. This evolution in teaching methodology underscores the importance of adapting to the changing landscape of education, ultimately enhancing the educational experience and fostering a deeper understanding of biomechanics among future physiotherapy professionals.

In Group A, which received app-based teaching, there was a statistically significant improvement in scores ($P<0.0001$). Ignacio López-Moranchel et al. reported significant differences favoring the experimental group, indicating increased interest in biomechanics and positive evaluations of the applicability of mobile applications in professional life. They suggested further research to explore the mechanisms underlying the success of such approaches to enhance student motivation.

There are some supporting articles by Palička, Pavel, the ongoing trend of integrating digital technology to support physical activity shows no signs of slowing down. With the increasing number of mobile device users, there's great potential for leveraging these devices to enhance biomechanics. This paper aims to provide insights into the use of mobile technologies for biomechanics in physical education. It discusses the broader application of digital technologies in education, with a specific focus on biomechanics, examining the efficacy of mobile apps.

Additionally, the paper includes a survey conducted among the participants assessing the current usage of mobile technologies in biomechanics. Initial findings suggest a strong inclination towards incorporating mobile technologies in biomechanics initiatives. However, the lack of standardized recommendations, such as peer-reviewed databases for educational apps, poses a challenge. Mobile apps present promising yet underexplored tools in promoting knowledge in biomechanics. Further research would be recommended to understand their effectiveness and address potential risks associated with their use in education settings. 38

In Group B, which received traditional teaching, there was also a statistically significant improvement in scores ($P>0.0001$). This finding aligns with the traditional use of applied biomechanics in analyzing movement in sports sciences and physiotherapy. Students perceive this discipline as complex due to its requirement for kinematic and kinetic measurements, necessitating mastery of mechanical concepts and practice in using measurement instruments

Another study by Robert J. Roselli et al. aimed to determine the effectiveness of traditional lecture-based instruction. Over a three-year period, comparisons were made between student performance on knowledge-based questions in courses taught using traditional teaching. These classes outperformed control classes significantly on 26 percent of the questions, highlighting the potential benefits of alternative instructional methods.

The study examined the outcomes using both Group A's Pre-Test A and Post-Test B, revealing significant findings. Likewise, statistical significance was observed in the Pre-Test and Post-Test results for Group B. However, when comparing the Pre-Test values between Group A and Group B, no statistically significant differences were noted. Nevertheless, the Post-Test values for Group A were markedly higher than those for Group B, indicating a significant disparity between the two groups.

Despite the limited support in existing literature for the novel technique being investigated, there are articles demonstrating that innovative techniques can enhance student knowledge and interest.

In summary, this study aimed to assess the effectiveness of app-based teaching versus traditional teaching methods in enhancing the knowledge and interest of undergraduate physiotherapy students. However, existing literature suggests that innovative teaching methods, such as app-based teaching, can positively impact student motivation and learning outcomes. Further research would be required to explore the underlying mechanisms and optimize educational strategies in this field. 37

Thus, to conclude the study there was significant difference between app-based teaching versus traditional teaching for undergraduate Physiotherapy Students. Thus, there was Hospital based Quasi-Experimental Study Design between app-based teaching versus traditional teaching show significant results on Validated Questionnaire.

IV. Conclusion:

The present study concluded that 16 weeks of protocol of app-based education and traditional teaching were shown to be significant improvement in scoring of pre-test to post test. When compared between these two techniques App based teaching was more effective in biomechanics than traditional teaching on improvement of knowledge among for Physiotherapy 2nd Year Students.

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