

# Physics Without Walls: Online Learning Journey

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**Abstract**— In the past, learning physics outside of the classroom received little consideration, but in recent times, it has gained popularity. The study provides a detailed explanation of how the COVID-19 pandemic has led to the teaching of physics as an industrial unit in the UAE. The study provides a clear and precise explanation of how to achieve distance learning in physics in the UAE. Furthermore, the study provides an explanation of the advantages and disadvantages of distance learning in comparison to the classroom scenario. It gives a clear and elaborate insight into how distance learning, especially in physics, corresponds to the classroom scenario. It also provides information on factors that can be considered to improve the current system and make it better. This study aims to examine the advantages and disadvantages of teaching the theoretical aspect of distance learning, particularly in light of the presence of numerous advanced mathematical problems. The study also concentrates on enhancing physics teaching through distance learning and identifying the obstacles that impede its delivery. As for the application side and practical experiments, the study helps to determine whether the virtual laboratory and computer simulation experiments are sufficient and can replace the traditional laboratory.

**Keywords**— Physics, online learning, UAE, distance learning, COVID-19

## I. INTRODUCTION

The COVID-19 pandemic has led to changes in the education sector as it is highly contagious and infectious. People have had to adapt to new methods and unfamiliar lifestyles, forgoing most things in the process. The education sector is among the most affected [1,2]. Many countries have adopted distance learning, finding traditional classroom attendance risky due to the coronavirus's promotion [3,4]. Learning physics via distance learning has been a beneficial aid in ensuring that the students are moving on with their healthy lives as they continue to study theory and practical aspects of physics [4,5]. It plays a role in ensuring that students finish their studies in time, tackle real-life issues, and attend their preferred universities with the required and necessary knowledge for tertiary education [6,7]. Since the pandemic is a global menace that has affected every part of the globe, the United Arab Emirates (UAE) is no exception [8]. As a result, schools have chosen to continue teaching their students through distance learning to enable them to gain knowledge during these tough and trying times. All factors considered, there are no exemptions, as all the subjects required and included in the curriculum must be studied exhaustively without leaving anything out [9, 10, 4].

The goal of this study is to figure out how to teach physics to high school students remotely. The COVID-19 pandemic has made it difficult for people to gather in a classroom, making it necessary for stakeholders in the education sector to find other methods of ensuring students continue learning. To cope with the pandemic's challenges, the UAE has engaged in distance learning to cope with the challenges caused by the pandemic. However, distance learning has struggled to teach subjects like theoretical and practical physics [8,10]. The study aims to evaluate some of the advantages and disadvantages of distance learning. The study also highlighted potential enhancements for physics distance learning, including the use of virtual laboratories and computer simulations (CSs) to facilitate the practical aspects of physics teaching [11,12]. The study also discusses some of the hindrances to learning physics through distance learning and suggests potential solutions. The study also provided justification for encouraging distance learning during the COVID-19 pandemic and established a framework to enhance students' essential skills through practice. It also assessed the implications of distance learning for solving physics-related problems.

## II. HOW PHYSICS STUDENTS AND TEACHERS ADAPT TO ONLINE LEARNING

The UAE may have had an advantage over other nations due to the establishment of an online platform for research and study under the name of the madrasa [4,8,13]. The program, which began in 2018, aimed to provide students in the country with reading materials in a straightforward and more understandable manner. It might give them an advantage over other nations, but not on some subjects that require intense study. One such issue is physics, which has both a theoretical and a practical part [14]. Therefore, such a subject must be administered like any other subject, as it requires a combination of tactics to ensure maximum cooperation, delivery, and supervision to avoid any form of injuries or errors by the students at their homes [15,16].

According to [2], implement various factors and measures to ensure the smooth continuation of learning. One may consider factors such as the availability of resources, their cost, and the willingness of both the child and the guardian to assist and participate in the learning process. Physics is a science and art that consists of a lot of critical thinking and quite a complex formula, which leads to complicated mathematical problems that must be solved [2,17-19].

To ensure that the students retain the basic skills they learn through distance learning of physics, introductory courses

should be provided to help improve their problem-solving skills and implement a framework for studying theoretical physics, which has a lot of mathematical problems. The study should pinpoint the issues students encounter while learning physics, enabling the development of targeted skills tailored to each student's unique challenges [4,6]. Distance learning should also incorporate immediate feedback on the progress of the student, computer-based instructions, well-researched principles, mastery grading, and cognitive psychology, which involves distributed practices and training sequences [6,20]. Student satisfaction and improved grades can be used to determine the effectiveness of teaching physics through distance learning in the UAE [8,21]. Problem-solving in physics is an integral part of the course, and hence teachers should focus on it when delivering distance learning [22]. It requires fluency and accuracy to perform simple tasks such as the addition of vectors and unit conversion [23].

Physics, as an art, requires one to learn a few tricks as well as practical skills, so a well-defined platform must be put in place to allow for the learning process [24,25]. Like any other subject, the unit necessitates evaluation to gauge the student's understanding of a particular aspect. Since this has become the new normal, both the UAE and the rest of the world should consider empowering and investing resources in this field, as it has the potential to gradually replace the current system [15, 26]. With all factors considered, the system does have its pros and cons. Despite technological advancements, the system still faces failures due to factors like cost and inadequate supervision. Despite being new and introduced out of necessity, the system also offers its advantages.

### III. UAE HIGH SCHOOL PHYSICS: DISTANCE LEARNING

To facilitate online learning, one needs several tools as well as skills for the whole process to become a success [27,28]. The tools include applications that create an interface between the tutor and the students. It provides students with much-needed resources for distance learning, such as books. It also allows for facetime, enabling one-on-one interaction between the teacher and their students. It acts as the link between the teacher and student, facilitating learning through the sharing of theoretical and practical physics information [15,29]. For the practical functionality of the interface and to obtain optimal results, specific protocols and regulations have been put in place to ensure maximum results are achieved.

Some of the established guidelines aim to govern and regulate the behavior of the students, while others serve to monitor the tutors and ensure they are using the appropriate techniques. In physics lessons, it's crucial to maintain a high level of interaction to help students comprehend various concepts. This understanding enables them to tackle a variety of mathematical problems, ultimately aiding in the resolution of real-life issues [30,31]. Delivering pedagogical knowledge to students is one significant measure laid down [32]. Given that the teacher isn't physically present, the manner in which he imparts the content he has mastered is crucial. This approach is accurate because it forms the foundation of the teaching process, with each guide striving to guide the learner in a manner that enhances their understanding. The UAE encourages tutors to possess a thorough understanding of the subject matter, enabling them to present a comprehensive and comprehensible approach to the issues at hand [18,33]. Given the inherent genetic differences in students' understanding levels, it's crucial to create concise and accurate notes that help students enhance their comprehension. The ability to organize

various tasks in an orderly manner is a crucial aspect of distance learning in physics, as it ensures a systematic education for students and fosters their knowledge growth with each daily study [34]. When the work is not well-structured, learners may become disoriented due to its lack of coherence, potentially leading to the omission of crucial physics topics [35]. A missed concept can cause many problems, not only in the field of study, but also in the future when tackling real problems.

The teachers also know the task's tools and apps. Technical teachers play a critical role in helping students feel at home with the interface and feel comfortable with the application [36,37]. Virtual learners may be unfamiliar with the applications and may find them challenging, just like first-time users. The teacher's ability to navigate through the applications comfortably gives the students an edge, as they are likely to learn from them and end up having the know-how to operate the same [38]. Schools, particularly high schools, serve as social hubs, and it is crucial to integrate this element into the online system [3]. The creation of an online community, where everyone holds a specific position in the communal chain, fosters a sense of inclusivity in both learners and teachers [3,15]. Therefore, the system should incorporate this feature to ensure everyone's comfort. The welcoming atmosphere created provides a conducive learning environment for everyone, leading to better learning outcomes.

The system also has its ways of assessing the student's daily progress. It assists in monitoring the student's progress and identifying those who may be encountering problems, as well as areas that might require special attention for the sake of the whole class [39,40]. We have adopted several distance learning methods, some of which are nearly 100% efficient, with nearly 80% of students favoring their implementation [41]. The methods are primarily based on the learning process's four main steps. Before proceeding to their first and second tests, students must review their previous encounters within a two-week timeframe [36,42]. This approach enables students to adjust and acquire knowledge within the designated timeframe for each topic.

The learners have the opportunity to provide their own opinions on the entire course during the final phase of course feedback [43]. The different evaluations that come in between the learning can be classified into different groups depending on their intensity as well as the timing [15,43]. High school physics, like other subjects, uses assessment as a tool to demonstrate the student's competency, knowledge, and skill [44].

The most common of them all is the use of quizzes. Quizzes are brief, timed questions typically given at the conclusion of each chapter. Its main aim is to evaluate the student's knowledge of an individual section. The correlated arrangement of the chapters makes it indispensable, as a student may become lost if they overlook a crucial concept from a single chapter [18]. The quizzes eliminate this issue by requiring learners to review and comprehend the material before taking the timed tests, which also factor into the unit's final grade. The other most prevalent method is the use of real-time quizzes. They are quicker, and the students must have the answers at their fingertips [18]. This pressure compels them to comprehend the subject matter thoroughly, enabling them to provide accurate responses to the questions presented. The test is the other important and conclusive method. It covers a

whole lot of coursework, unlike the quizzes, which cover small areas. For the final paper, you can administer it twice or even once. In this, they are the ones with the most points and are, therefore, a crucial part of determining one's grade and establishing whether it is a failure or a pass. To facilitate ease of access for everyone, we should develop a well-structured and device-independent platform for the above methods.

Physics, being both an art and a science, necessitates a practical component. It is no longer feasible or probable to conduct actual tests and experiments in the labs. Therefore, researchers have embraced alternative methods to streamline the process. Simulations are the most widely used of these adoptions. In this method, the simulator acts as a virtual lab and eventually gives the learner the required results for an individual experiment [11,12,30]. Unlike labs, where one conducts investigations and interacts with various apparatus, this method simply gathers the results and potentially develops a virtual system.

Because it is a recreation of a real-world scenario, the learner is required to come up with a mathematical model. This enables them to design the correct and most accurate experimental setup [35]. It also necessitates an engine that executes all necessary processes to achieve the desired results. Given that it operates via an interface, having a thorough understanding of it is critical. Since these are the only resources that aid in the recreation of labs and experiments, one has no choice but to learn about them [6,35]. All of the above measures and technological advancements have enabled the UAE's high schools to learn smoothly, even during these difficult and trying times. However, it is not without its challenges, as most technological advancements never lack room for improvement. Being a new experience to everyone, it hasn't been an effortless task to adapt and fit in perfectly, but most of the involved parties have tried their best to fit into the new system.

#### IV. ADVANTAGES AND DISADVANTAGES OF DISTANCE LEARNING

The system has its cons and pros, just like any other system. It provides flexibility, among other advantages. In this aspect, flexibility gives one the freedom to choose the place and time to schedule the teaching. This approach incorporates everyone into the schedule, thereby enhancing convenience [45]. This method of learning provides a platform for greater learning opportunities. The system's flexibility, resulting from reduced travel and location independence, allows for minimal time wastage, thereby enhancing one's knowledge [30]. Therefore, this system provides more time for learning compared to traditional classroom settings. The ease of sharing information is another benefit of this new method. Online servers host most learning platforms, making it simple to access the necessary information. If the information is unavailable, you can conduct routine searches on search engines. Unlike the classroom scenario, physics is a vast discipline that requires one to be well-informed on the concepts, making this method highly beneficial. In this method, almost 75% of the learners will obtain more information than in classrooms, which is excellent for them because they better understand the subject matter [46].

Because it is less complicated, the system provides better interaction for teachers and learners. In most scenarios, the classrooms have many students, which makes it almost impossible for the tutors to interact with every student in a

one-on-one capacity. However, the new system has addressed this issue by enabling teachers to engage directly with their students. By doing so, the students have a better understanding of the concepts as well as the mathematical expressions, which could have proven a nuisance in a classroom setting [18]. It also favors shy students who rarely ask questions in class, as they are more comfortable dealing with the teachers alone and even indirectly [8,11].

Distance learning also has drawbacks that work in the stakeholders' favor. Distractions are a common occurrence [8, 47]. Disturbance during education is one of the major distractions that impact distance learning [18,48]. Learning from home can sometimes cause a lot of distractions, and interruptions can occur from nearby noises [49]. The cost of distance learning is relatively low compared to that of classrooms, which might require a lot of travel [50]. However, it's important to note that there are numerous hidden costs associated with distance learning that can be difficult to identify. The hidden fees can be one-time while others are recurring. For efficient learning, one must make the installations on their devices, as well as ensure they have a stable and reliable internet connection [51].

Schools are social settings that allow for interactions with people from different cultures as well as having different experiences [52]. One, therefore, gains a lot of connections while in school, especially from their classmates, which is a tremendous help for their future development [53]. While studying online, one interacts only with their teachers. This minimizes the networks, potentially harming one's future aspirations or even leading to the loss of a potential job. Distance learning results in minimal interaction between learners, which in turn leads to reduced creativity. It acts as a hindrance to innovations, which often stem from the ideas shared among learners. Therefore, from this perspective, it is an enemy of progress.

There are several obstacles that make distance learning difficult, particularly for industrial units like physics. One such factor is the group's need for practical experiences, which often lack online platforms. Despite the simulations providing excellent and accurate results, the students lack the experience of having first-hand tests and interactions with the instruments [12,45]. This deprives them of crucial exposure to the job market. This could potentially pose a significant disadvantage, as many students find themselves ill-equipped to navigate real-life scenarios.

Another major challenge is the lack of skill among users. The platforms necessitate a certain level of experience for effective interaction. Due to the majority of users being first-timers and their prior exposure to classroom learning, the platform suffers from a lack of experience [51]. This could potentially lead to a shift in mindset, making it more challenging for learners to comprehend the material in the classroom. 90% of learners are more inclined to the learning environment they are well acquainted with, thus making this method a bit harder [45]. The rather flawless distance learning could face a massive blow as soon as normalcy resumes.

#### V. UAE PHYSICS DISTANCE LEARNING IMPROVEMENTS

Distance learning is a relatively new phenomenon, with several factors both contributing to its improvement and impeding its overall progress. One significant challenge that arises from this is the lack of delivery on the student's end. It could be due to a lack of inclusivity in schools. The students

tend to feel alienated, which makes them less receptive to the course [3,42]. Understanding the various concepts in Physics requires full engagement. The feeling of exclusivity makes the students lose interest. To overcome this challenge and improve the online platform, the teachers should keep tabs on the students. Regular conversations with the students can achieve this. It allows them to channel their grievances as well as feel engaged and included in the class's activities [45,50]. The students end up developing an interest, which makes it easier for them to understand. By achieving this, the learner's performance is much improved. If the system can deliver at a higher capacity than the classroom setting, then it is the way to go.

Another crucial issue in this setting is the learner's attitude. The learner's perspective needs to be fit for online learning. The students are required to have developed an interest in a particular subject. This enhances the interactions, transforming the platform into a classroom-like environment. By doing so, the system will have made an enormous step forward, as it is now more of a virtual classroom than just an interface [6,8]. Several methods are available to achieve this. One such method is the use of peer questions, which involves constantly asking students simple concepts to foster interaction. This method has been extremely successful, especially in technical courses like physics. Another technique that has achieved greatness in a particular field is that of asking context-rich questions that might demand the student's attention to come up with an answer. Engaging the learner and creating a classroom-like environment enhances the learning experience. Students are required to work in groups to facilitate their interaction, as the questions require detailed answers. It helps create a virtual classroom as well as a lab for the experiments [52]. It accomplishes this by encouraging collaborative groups to apply conventional methods and strategies [6,52]. This eliminates the bias of working alone and coming up with completely different solutions. It gives the platform a more centralized approach, just like it does in a classroom.

Reducing costs is another crucial factor that can propel this phenomenal development [4,46]. The price includes internet costs, which may discourage learners due to their limited financial resources. Therefore, we can install a stable and efficient internet connection at no cost to motivate learners. Another factor that can help significantly in improving this type of learning is providing free training among the teachers. By doing this, the teachers become well-informed about the specific system. This improves the quality of content delivery, which, if achieved, could make the system superior to the classroom setting and even replace the order.

## VI. CONCLUSION

The UAE's education system faces a crossroads. Technology-driven distance learning is gaining momentum and has the potential to transform physics education. While convenient and potentially cost-effective, it struggles with replicating the practical aspects of laboratory work. Ignoring this gap, blinded by its advantages, would be a mistake.

Distance learning, when well implemented, might eventually replace traditional classroom learning. Research suggests this shift could take a decade. However, physics, particularly its practical aspects, presents a unique challenge in this transition. Both teachers and students need to grasp the difference between traditional and remote learning, especially

in fostering practical skills. Despite the challenges, distance learning presents a positive aspect. Its student-centered approach allows for independent exploration and problem-solving, which are critical areas in physics education. As technology becomes an integral part of successful learning programs, the UAE, with its positive response to online physics education, is well-positioned to be a leader in this evolving field.

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