AEROSPACE PALACE ACADEMY, NIGERIA
(A subsidiary of Aerospace Palace International, Nigeria)

WEBSITE: www.aerospacepalace.com.ng, https://aviationpalace.wixsite.com/aerospace **EMAIL:** aviationpalace@gmail.com

OUR E-LEARNING COURSE CONTENTS

Instructional Design Guide

General Program Details

Course Name	**ONLINE STEM EDUCATION AND AEROSPACE MICRO-LESSON**
Degree/qualification	Certificate / Self Development / Professional Development
Awarding Institution and accrediting(s) i.e. NCHE, if any)	Aerospace Palace International, Nigeria
Course Curriculum Author	Aeroversity, Nigeria
Course overview and aim	These lessons are easily digestible lessons focused on aerospace principles. Each lesson is broken down into grade levels and is meant to spark conversation and interest in aerospace. Lessons will range from engineering to mathematics, to physics, to highlighting aerospace anniversaries -- all of which will be presented in a way that easily relates to your students. For this programme, we have 92 lessons in all. The mini-curriculum is subdivided into 19 course-packs. At the end of each pack, we have 10 selected multiple choice questions with 2 each from the 5 topics. The online STEM Education and Aerospace Micro-Lesson is designed to inspire, influence, and mold the next generation of aerospace scientists and engineers by providing a series of resources and programming to teachers, students, parents, and aerospace professionals. The programs enlighten and engage our global community of future aerospace professionals by helping them learn more about science, technology, engineering, and mathematics. The developing countries have suffered a series of decadence in Aerospace and STEM Education, therefore our mission is to stimulate a lasting interest in the STEM disciplines, with the goal of encouraging students to pursue careers in these fields. This is accomplished by actively involving students in the support of authentic research currently being conducted on the International Space Station (ISS) or in a NASA ground-based laboratory. Through collaboration with AIAA, Space Foundation and researchers, we have created educational mini-curriculum for the university, college, high school or middle school classroom that engages students as research assistants, providing data for the Principal Investigator.

Student characteristics and knowledge level	- Pupils and Student at all levels - Age 08-15 - Age 16-18 - Age 19-25 - Age 25 above
Student hooks (intrinsic motivation) within the topic-Why this course?	In Africa, average African lives on amount less than $2 per day and hence cannot afford the huge cost of education; especially Aerospace and STEM education. Hence, this is a problem we designed our project to solve by making education accessible, affordable, cheaper and reachable to an average Nigerian. Around the globe, particularly in developing countries, women and youths lack opportunities to obtain the education that they so desperately need and deserve. Cultural stigmas, religious restrictions, and oppressive laws keep women trapped in desperate poverty and ignorance, unable to obtain the education that might give them hope. History has shown time and again that educating girls provides benefits to the economies of nations. In many cases, changes in cultural attitudes and the legal status of women have resulted in economic benefits that break the cycle of centuries of poverty in just a single generation. The fields of Science, Technology, Engineering, and Mathematics (STEM) are critical to any nation seeking to grow in the 21st century global economy. A robust and democratic economy will require citizens thoroughly equipped to compete in the science and technology fields. STEM-focused education responds to the reality that a nation's future will be built its capacity for innovation and invention. Our feasibility study showed that majority of our target audience spend most of their time on their mobile phones and laptops using various applications on the go than they do inside a conventional classroom, hence we decided to take our virtual classroom to every home where a phone, laptop and internet facilities exist. We believed that once, not long ago, classroom space was considered an essential component for nearly every school and training institutions. You'd fill it with desks, chairs, telephones, a fax machine and photocopier and then people, who'd arrive each day at 7am and leave by 7pm. Most of us still utilise classroom space to some degree, but increasingly its role is shifting from essential to optional extra because the powerful mobile devices, the cloud and social collaboration tools are enabling staff and teachers/educators to step outside the traditional confines of classroom and chalkboard.

Learning outcomes	By the end of the course, students should be able to:
	• Understand the basic concepts of Aerospace Micro-Lessons
	• Understand NASA mission and objectives.
	• Understand the basics of Space Science, Aeronautics and Astronautics
	• Identify the basic components of an aviation environment, controlled and uncontrolled airports, the forces of flight
	• Compute some basic mathematics and physics associated with subject matter.
	• Conducting the research (the heart of the mission) which may include:
	    ○ Hypothesis development
	    ○ Observation and photo/video analysis
	    ○ Data recording and submission
	    ○ Formulate conclusions
	    ○ Evaluation
	    ○ Classroom lab activity mirroring the actual research

Assessments	Assessment shall be carried out through 10 short multiple questions based on the current course content only.

Delivery mode	• eLearning
Course duration	1 month – 3 months depending on the student's determination and commitment to the programme.
Sessions in the course:	In conjunction with our partners, we have developed an American Institute of Aeronautics & Astronautics (USA) and Space Foundation (USA) approved curriculum covering over 65 lessons. The mini-curriculum for schools and colleges consists of 65 courses and subdivided in 13 course-packs for easy accessibility. At the end of the pack, we have 10 selected multiple choice questions with 2 each from the 5 topics. The assessment for each pack comes at the end of the last lesson for the pack. **LESSON PACK 1:** (1) Aerospace Micro-Lesson 1 -- The Earth's Hemispheres (2) Aerospace Micro-Lesson 2 -- Orbital Debris (3) Aerospace Micro-Lesson 3 -- Living In Space (4) Aerospace Micro-Lesson 4 -- Large Numbers (5) Aerospace Micro-Lesson 5 -- Observing the Moon **LESSON PACK 2:** (6) Aerospace Micro-Lesson 6 -- Up, up, and Away in my Beautiful Balloon (7) Aerospace Micro-Lesson 7 -- How Long is a Day (8) Aerospace Micro-Lesson 8 -- Orbital Dynamics (9) Aerospace Micro-Lesson 9 -- Transit of Mercury (10) Aerospace Micro-Lesson 10 -- Jackie Cochran **LESSON PACK 3:** (11) Aerospace Micro-Lesson 11 -- Gemini VIII (12) Aerospace Micro-Lesson 12 – Airspeed (13) Aerospace Micro-Lesson 13 -- Asteroids and Dinosaurs (14) Aerospace Micro-Lesson 14 -- Spinning Ball of Water in Space (15) Aerospace Micro-Lesson 15 -- Metric Units of Measurement **LESSON PACK 4** (16) Aerospace Micro-Lesson 16 -- How do Airplanes Fly (17) Aerospace Micro-Lesson 17 -- Parallax and the Size of the Solar System (18) Aerospace Micro-Lesson 18 -- Hedgehog Robot (19) Aerospace Micro-Lesson 19 -- The Mariner Project (20) Aerospace Micro-Lesson 20 -- How Long Is A Year **LESSON PACK 5** (21) Aerospace Micro-Lesson 21 -- Images from Space (22) Aerospace Micro-Lesson 22 -- The Magnus Effect (23) Aerospace Micro-Lesson 23 -- The Rosetta Mission (24) Aerospace Micro-Lesson 24 -- Measuring the Size of the Universe (25) Aerospace Micro-Lesson 25 -- Antoine de Saint-Exupery **LESSON PACK 6**

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(41) Aerospace Micro-Lesson 41 -- Hoaxes and Bad Science
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OUR ESTEEMED PRINCIPAL INVESTIGATORS (PI) AND THEIR RESEARCH WORKS

1		**STEM CELLS STUDY ON STATION** In this experiment, Principle Investigator (PI) Dr. Abba Zubair of the Mayo Clinic at Jacksonville, FL, studies the effects of microgravity on three types of human stem cells (cancer, hematopoietic, and mesenchymal). He wishes to identify if stem cells can expand (increase in number) in microgravity, assess the feasibility of generating clinical grade stem cells in microgravity, and evaluate the efficacy and safety of microgravity grown stem cells. Dr. Zubair ultimately wishes to be able to generate large quantities of stem cells in microgravity and then return them to Earth for use in patients who have suffered strokes or other debilitating injuries or illnesses. In collaboration with Dr. Zubair, we are offering teachers the opportunity to get their students directly involved in this exciting new research by joining the "Stem Cell Studies on Station" mission. Participating teachers will be provided with curriculum materials to help student understand stem cell types and expansion, to follow the work that has previously been done by Dr. Zubair, and to understand Dr. Zubair's current research. Students will gain access to the actual images of three stem cell types from both Dr. Zubair's space-based and ground-based experiments and will be guided through their analysis. Student data will be forwarded to Dr. Zubair for possible inclusion in his database.
2		**STEM ON STATION** This particular study is important because future exploration of the moon, asteroids or Mars will require long periods of space travel, which creates increased risk of health problems such as atrophy of the heart muscle. In addition, because conditions in space mirror the effects of aging on Earth, the finding of this research could not only help astronauts but also advance the study of heart disease and the development of drugs and cell replacement therapy here on Earth. In this experiment Principle Investigators (PI's) Dr. Joseph Wu of Stanford University and Dr. Peter Lee of The Ohio State University use human heart cells derived from non-embryonic stem cells to look for changes in things like beat rate, morphology and gene expression while in the microgravity environment of space. Now we are offering teachers the opportunity to get their students directly involved in this major new research by joining the "Stem On Station" mission. Participating teachers will be provided with curriculum materials, suggestions for classrooms activities and access for students to analyze actual video of the heart cells from both the space-based and ground-based experiments. Student data will be forwarded to the PI's for possible inclusion in their databases.

3		**MANAGING MICROBES IN SPACE** This research work get students involved in a journey of discovery as they support the work of NASA scientists looking for ways to protect astronauts in space. This experiment is a first of a kind study of the interactions of germs and host organisms in real time while in microgravity. By analyzing video downlinked from an experiment onboard the International Space Station and submitting their data to the Principle Investigator Dr. Cheryl Nickerson of the Biodesign Institute at Arizona State University, students will be engaged in real space-based research and work in support of NASA's Human Space Exploration program. Recommended for Middle and High School students.
4		**PLANT GROWTH IN SPACE** **DR. LOUIS STODIECK** of University of Colorado, Boulder **STEFANIE COUNTRYMAN** of University of Colorado, Boulder Our virtual mission "Plant Growth in Space" represents a decade of working with NASA scientists doing research in space. This tenth mission uses the plant species Brassica rapa or Wisconsin Fast Plants and is designed to shed light on the question, "How do plants react to microgravity in their early growth stages". As humans continue to expand the duration of space flights and the distance travelled from Earth the need for sustainability in space becomes essential. This investigation is designed to have students discover how the phototropic and gravitropic responses of plants grown in a space-based experiment onboard the International Space Station compare with those of plants grown in an earth-based control experiment. Students will participate in 4 activities analyzing FLIGHT and GROUND photos. Data collected in these activities will allow students to draw their own conclusions about the impact of microgravity on early plant growth and student data will be submitted to the Principle Investigator (PI) for the mission for possible inclusion in their databases.
5		**SPIDERS IN SPACE** **DR. LOUIS STODIECK,** University of Colorado, Boulder Our "Spiders in Space" virtual mission supports the research of NASA scientists and piggybacks on the "Fruit Flies in Space" mission. This space-based research project gathers data about the interaction and movements of the fruit fly Drosophila melanogaster and the orb weaving spider Nephila clavipesliving in the same habitat while onboard the International Space Station (ISS). The investigation focuses on the spiders and is designed to study the differences between webs spun in the space-based experiment and the earth-based control experiment. Students will be asked to do a variety of activities including measurement of the growth of the spider and observing and recording the web spinning process in microgravity. Students will participate in the activities by analyzing and comparing photos and video from both the space-based and earth-based investigations via our website. Student data will be submitted to the Principle Investigator (PI) for the mission.

6		**FRUIT FLIES IN SPACE** This virtual mission "Fruit Flies in Space" was part of the payload on NASA's STS 134 flight. It is a biology-based mission which focuses on the Fruit Fly Drosophila melanogaster and uses actual photographs, video and data downlinked from the International Space Station. The mission is designed to have students support the work of NASA scientist Dr. Sharmila Bhattacharya, Head of the Biomodel Performance and Behavior Laboratory at NASA Ames Research Center, as she studies the effects of microgravity on the development, behavior and movement of this organism. By studying the behaviors of the Fruit Fly and other model organisms in microgravity scientists contribute to the body of knowledge in understanding how organisms adjust to their environment. All organisms use the same basic signaling pathways and good data shows how changes in gravity alter these systems. Behavior changes can then be used to analyze the genetic basis for the change. Because the Fruit Fly genome has genetic similarity with the human genome information gained in studying these simple organisms can then be translated to complex human organisms. Students will report observations and measurements of the Fruit Fly behaviors by comparing photographic records from the International Space Station and an earth-based comparison study. Student data collected on our website will then be sent to Dr. Bhattacharya for review and possible inclusion in research databanks.
7		**BUTTERFLIES IN SPACE** **DR. LOUIS STODIECK,** University of Colorado, Boulder **MARY ANN HAMILTON,** Butterfly Pavilion, Colorado Launched to the International Space Station aboard NASA's mission STS-129 in November of 2009, this activity focuses on the ability of "Painted Lady Butterflies", Vanessa cardui to "pupate" in microgravity. This activity supports the research of the Butterfly Pavilion at Westminster, CO. Students construct a butterfly habitat in the classroom mimicking the structure and conditions of the "in-flight" habitat aboard the International Space Station. Utilizing the same butterfly larva and food supply being used in both the microgravity and ground control experiments, students follow the larva to pupa stage of the butterfly life cycle. At the teacher's discretion, students' access photos of the space and earth-based activities via our website and analyze these photos, comparing them with classroom outcomes. Data entered through the online interactive data page will be submitted to the Principle Investigator (PI) for possible inclusion in databases.
8		**SILICATE GARDENS IN SPACE** Our "Silicate Gardens in Space" virtual mission is a chemistry-based research study in support of the work of crystallographers Dr. Julyan Cartwright and Dr. C. Ignacio Sainz Diaz at the Laboratory for the Study of Crystallography in Granada, Spain. This investigation combines two experiments that were part of the payloads of NASA's space shuttle Endeavour missions STS-118 and STS-123. Both flights delivered their experiments to the International Space Station (ISS), STS 118 in August 2007 and STS 123 in March 2009. Silicate Gardens or Chemical Gardens have been studied on earth for many years and now the research continues onboard the International Space Station. Using sodium silicate solution and various metal salts, this research is designed to provide new information on the formation and growth of hollow tubes, the basic structures of silicate gardens, while in a microgravity environment. Student's record observations and measurements of silicate tube growth to evaluate one of several variables as they analyze and compare photographic

		records from the ISS with an earth-based control study. As a part of this ongoing study student data is submitted online and forwarded to Dr. Cartwright and Dr. Diaz for possible inclusion in their databases.
9		**WORMS IN SPACE** This high-flying education effort features a science investigation that supports of the research of NASA scientist Dr. Catharine Conley and genetic researcher, Dr. Nate Szewczyk. The study uses the soil nematode Caenorhabditis elegans(C. elegans), a free-living (non-parasitic) round worm about 1 mm in length as the model organism for the ongoing research that support NASA's program in the areas of Human Space Exploration and human genetics. Dubbed "CSI-01" this project allows students to participate in meaningful scientific research on gravity-dependent biological processes. This nematode experiment sponsored by the Malaysian Space Agency used an automated growth chamber designed and built by BioServe Space Technologies in Boulder, Colorado. Based on Dr. Conley's research the study provided video, still images and data that were downlinked to Earth from the International Space Station and placed on our website. Using these photographic records participating students observe and analyze C. elegans living in liquid media. The study is designed to provide scientists with data related to the effectiveness of the media and the effects of microgravity on life processes of the C. elegans. Observation of population densities and the tracking the progression of the worms through four growth stages are part of the study and student data is submitted to Dr. Conley and Dr. Szewczyk.
10		**CANCER MICROGRAVITY RESEARCH EXPERIMENT (CµRE)** In this experiment, Principle Investigator (PI) Dr. Shou-Ching Jaminet studies the effects of a novel cancer drug delivery system on healthy cells using microgravity to model an in-vivo experiment. Through an antibody-drug conjugate, Dr. Jaminet can deliver a cancer drug to diminish tumor growth by targeting the blood vessels that feed tumors. Dr. Jaminet hopes to show that the drug is safe to non-cancerous cells so that the drug may go to clinical trials.In collaboration with Dr. Jaminet, we are offering teachers the opportunity to get their students directly involved in this exciting new research by joining the CµRE (Cancer Microgravity Research Experiment) mission. Participating teachers will be provided with curriculum materials to help student understand Dr. Jaminet's experiment. In addition students will gain access to actual images from both the space-based and ground-based experiments and will be guided through their analysis. Student data will be forwarded to Dr. Jaminet for possible inclusion in her database.