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Research Article

EXPERIENTIAL LEARNING ACTIVITIES OF STUDENTS' IN MECHANICAL/AUTOMOBILE TECHNOLOGY EDUCATION FOR DEVELOPING COMPETENCIES FOR 21ST CENTURY

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Abstract

The knowledge age is altering the way the world works and universities have the obligation to best prepare students to take advantage of the opportunities that are available to them. Thus teaching and learning methodology and organization in universities needs to change if students are to develop the range of innovative skills necessary to survive lifetime in the twenty-first century. However, key to this will be the students' willingness and determination to become involved in the process and engage with practical oriented subjects that add meaning to their worlds. This increased focus and engagement in learning will lead to the development of a much broader range of attitudes, values, competencies and dispositions enabling them to respond positively to opportunities. Therefore, the study focused on determining the experiential learning activities essential of students' in mechanical/automobile technology education for developing competencies for 21st century and differences across levels of academic instruction. The research adopted a descriptive survey design. Four research questions guided the study and two null hypotheses were tested at 0.05 level of significance. The target population of 251 full-time students; in mechanical/automobile technology education in a Public University in Anambra State, participated in the study. A structured questionnaire of 94–items was used for data collection. It was face and content validated by three experts. Mean and standard deviation were used to answer the research questions. The Kruskal Wallis was used to test the hypotheses. Based on the analysis, it was concluded that mechanical/automobile technology students' are required to engage in experiential learning activities involving critical thinking/problem solving, communication, collaboration and creative / innovative for developing competencies of 21st century. It was therefore recommended that in the course of curriculum implementation, mechanical/automobile technology lecturers should devote a substantial proportion of teaching and learning time to experiential learning activities for developing competencies for 21st century. Thus the graduates would possess requisites employ able skills, engage in wealth creation and become entrepreneurs.

Keywords: Experiential Learning Activities, Mechanical/Automobile Technology and Competencies for 21st century.

INTRODUCTION

Technology education is that facet of education that prepares an individual for the acquisition of practical skills for gainful employment. Technology is intervention by design the know-how and creative process that could utilize tools, resources and systems to solve technological problems and enhance control over the natural and man-made environment with the aim of improving quality of life (Ministry of Education, 2007). Similarly, technology is the ability to improve on the ways things are done for better performance, and it is only through the application of appropriate technologies (Jukes, McCain and Crockett, 2010). In the same vein, technology could be constructed within a particular culture taking into consideration of the social and cultural needs of the society in which it was developed. Furthermore, technological resolutions developed within the context of the community, in which the need arrives, could use local skills, resources and existing technologies are likely to be the most successful. Accordingly, for any developing nation, the level of economic growth is tied to the level of technology that exists therein. However, there is no doubt that the nations of the world that are technologically and economically strong have the story of their success rooted directly to investment in technology and vocational education. Therefore, mechanical/automobile technology undergraduates should work in a variety of collaborative and cooperative ways, engaging with the wider community and frequently incorporating service learning as an added component.

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Consequently, students who actually engage in higher-order thinking skills, multiple literacies, technology and multimedia, and complete authentic assessments and could promote practical learning activities. Obviously, the multi-disciplinary nature of technology is ideal to integrate diverse knowledge and understanding that is rich in meaningful and purposeful content and engagement (Fox-Turnbulland Snape, 2011). Essentially, adaptation and innovation are at the heart of technological practice as well as quality outcomes could result from thinking and practices that are informed, critical, and creative. Technology is generally designed to bring about industrial development which in turn is a major key player in economic development (Jukes *et al.,* 2010). This means that, the world of industries are the source of instructional content for technology education programme. The following programmes can be offer under technology education such as, electrical/electronic technology, woodwork/building technology and mechanical/automobile technology etc.

Mechanical technology is the art of using problem-solving techniques and applying them to the design and manufacturing of an article and object. A mechanical technology uses creative design and analytical knowledge to turn a concept into something real. Mechanical technology plays a critical role in manufactured technologies, from cars to airplanes to refrigerators. Without mechanical technology, we would not have things like engines, generators, elevators or even air conditioning. Essentially, mechanical technology enables us to carry out numerous daily activities with ease, as it brings helpful technologies to our modern society. It is one of the most important subdivisions of engineering, because without

it, many of the technologies we use every day would not be available. Basically, a career as a mechanical technologist who works cooperatively with engineers to install, maintain, test, plan for, and produce mechanical parts according to given specifications.

Automobile technologist are expected to test, diagnose, service, and completely repair any fault relating to the conventional vehicles and also assemble main units and systems by following the manufacturers' specifications (Gill, 2010). The appropriate teaching and learning of automobile trade will qualify both male and female students for the world of work. It would enhance their academic achievement and as well qualify them for the higher educational level that would enable them to become knowledgeable in the field of technology (Ukit, 2013). The implication of this is that auto-mechanics teachers especially in University education should develop and employ instructional methods which should encourage students to participate actively in the learning process. Automobile technology could to produce competent technicians in auto-mechanics trade for Nigeria's technological and industrial development. To achieve effective and efficient instructional delivery in automobile technology it is necessary to employ student-centered learning approach such as practical oriented learning activities for developing competencies for 21stcentury. There are wide range of design models that aim to embed learning within real world contexts, including: laboratory, workshop or studio work, apprenticeship, problem-based learning, case-based learning, project-based learning, inquiry-based learning, cooperative-based learning and experiential learning.

Experiential learning is the process whereby knowledge is created through the transformation of experience. Kolb, (1994), one of the main exponents of experiential learning, proposes a four-stage model as (i) concrete experience (ii) observations and reflections (ii) formation of abstract concepts and generalizations, and(iv) active experimentation with new concepts as illustrated in figure 1.According to this model, a learning process begins with a concrete experience, followed by reflective observation. Reflection is then assimilated into a theory by abstract conceptualization before, new (or reformulated) hypotheses are tested out in new situations. The model can be characterized as an iterative learning cycle within which the learner tests and modifies new ideas and concepts as a result of reflection and conceptualization. The use of here-and-now experience to test theories in practice, as well as the use of feedback to modify these theories, are two significant elements of experiential learning. This theory explains learning as an iterative process in which knowledge is generated by processing experience.

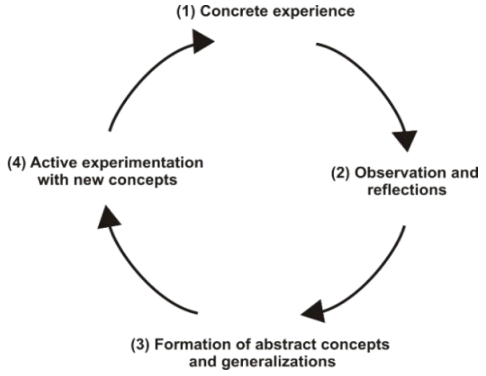

Fig. 1: **Kolb's Cycle of Experiential Learning Activities**

However, Passarelli and Kolb, (2012) maintained that for a learner to engage fully in their learning activities, a space must be provided to engage in the four modes cycle of feeling, reflection, thinking and action. In experiential learning, the experience of the learner, which may encompass earlier events in the life of the learner, current life events, or those arising from the learner's participation in activities implemented by teachers and facilitators. It is very necessary that this should occupies a central place in teaching and learning activities. Learners could analyze their experience by reflecting, evaluating and reconstructing it in order to draw meaning from it in the light of prior experience. Accordingly, Lewis and Williams, (2014) asserted that students could process real-life scenarios, experiment with new behaviours, and receive feedback in an experiential learning situation.

Therefore, practical learning in physically real workspaces could provide opportunities for experiential learning, because the learner may perhaps experience theory in a more familiar form, since the practical experiment enables the students to observe and reflect on the results of learning tasks and assignments. Each experiment or practical work task may therefore be seen as a starting point for understanding the underlying theoretical principles. In the same vein, action and reflection are the core attributes of learning through experience or experiential learning. This requires a teaching methodology in which students are engaged in doing activities and reflecting on what they did. Our knowledge acquisition techniques are based on virtual and remote laboratories, simulations, or real life experiences in local workshops and work spaces. Thus it necessarily to maximize the learning effectiveness by looking for the right combination of such methods. Similarly, combining workshop experiments with virtual learning accords with the concept of experiential learning, in the laboratory experiments could be used as a learning assistance, rather than a learning objective in itself. Hence, laboratory experiments and practical exercises could provide a hands-on approach to learning activities. Also could allow a learner to experience data in a more familiar form, since the practical experiment proposed to the students could enable them to observe and reflect on what they have just witnessed. Each experiment may perhaps be seen as a starting point that will lead them to an understanding of its underlying theoretical principles.

Furthermore, Gentry in Elam and Spotts, (2014) stressed some activities in experiential learning to include case discussions, group cases, simulation games, descriptive/analytic field projects, computer assisted instruction, internships and live cases. Accordingly, Machali, (2012) asserted that experiential learning supports a more participative, learner-centered approach to learning and places much emphasis on direct engagement, rich learning activities and the construction of meaning by learners. *In this study, experiential* learning activities was designed to support the competencies of 21st century learning.

The organization for Economic Co-operation and Development (OECD), (2003) in its Definition and Selection of Competencies (DeSeCo) Project asserted that:

'*Competency is more than just knowledge and skills. It involves the ability to meet complex demands, by drawing on and mobilizing psychosocial resources (including skills and attitudes) in a particular context. For example, the ability to communicate effectively is a competency that may draw on an individual's knowledge of language, practical information and*

technology skills and attitudes towards those with whom he or she is communicating (OECD), 2003)'

21st century competencies according to Chalkiadaki, (2018) encompassed a broad range of skill sets and professional attributes comprising: creativity, divergent thinking, critical thinking, communication, team working, cognitive and interpersonal skills, social and civic competences, responsible national and global citizenship, consciousness of interdependence, acceptance and understanding of diversity, recognition and development of personal attributes, interactive use of tools, digital competence, sense of initiative and entrepreneurship, accountability, leadership, cultural awareness and expression, physical well-being.

Therefore, 21st century learning contains 21st century competencies or skills which include process of thinking, methods of working, tools of working and living in the world (Griffin, Care and McGaw, 2012) as exemplified in figure 2. Accordingly, Silva, (2009) listed fifteen 21st century competencies such as creativity/innovation; critical thinking; information literacy; problem solving; decision making; flexibility and adaptability; learning to learn research and inquiry; communication; initiative and self-direction; productivity; leadership and responsibility; collaboration; ICT operations and concepts; digital citizenship and media literacy. The 21st century is a century of the rapid development of science and technology. Development takes place in various sectors so that it requires humans to work with complex thinking and communication skills (Berry, 2010). Thus the requisite 21st century competencies according to Scott, (2015) are the knowledge, skills and attitudes necessary to be competitive in the workforce, participate appropriately in an increasingly diverse society, use a series of new technologies, and cope with the rapidly changing workplace. Furthermore, automation is a more current technology, and as a result, employers are now hiring people for jobs that require more critical thinking, digital skills and sophisticated communication skills (Dunning; Levy and Murname as cited in Chu, Reynolds, Notari, Taveres and Lee, 2016). Also, Wagner, (2008) in The Global Achievement Gap, has advocated seven survival skills for the twenty-first century: critical thinking and problem solving; collaboration across networks and learning by influence; agility and adaptability; initiative and entrepreneurialism; effective oral and written communication; accessing and analyzing information; and curiosity and imagination These rapid changes taking place in the workplace today with the increasing complexities make it all the more important for educators to strive to equip their students with 21st century competencies. 21st century learning management based on experiential learning aims to help students construct knowledge and is expected to improve students' understanding through hands-on learning experience.

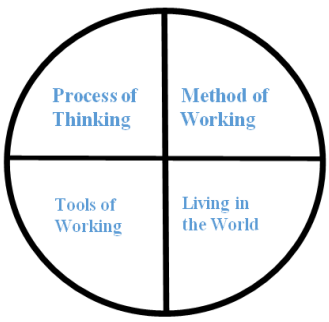

Figure 2. 21st Century Skills

Based on the 21st century learning concept, implementation in formulating a 21st century learning framework in Indonesia is multidisciplinary. This is contained in the Indonesian Partnership for 21 Century Skill Standard (IP-21CSS) as illustrated in table 1. Accordingly, Joynes, Rossignoli, Fenyiwa and Amonoo Kuofi, (2019) stated that '4Cs' model is based on the assertion that 21st century challenges will demand a broad set of skills emphasizing the individual's capabilities in core subject skills, social and cross-cultural skills, proficiency in languages, and an understanding of the economic and political forces that affect societies Further, Joynes et al., (2019) identified the framework for 21st century learning' proposed by the US-based Partnership for 21st Century Learning (P21) highlighted the '4Cs' (critical thinking, communication, collaboration and creativity) as a range of attributes that should be developed within the context of teaching core subject areas in the 21st century (as illustrated in Table 1).

Critical thinking/problem solving refers to the ability to use knowledge, facts, and data to effectively solve problems. This does not necessary means that one need to have an immediate answer, it could means one should be able to think on his feet, assess problems and find solutions. Also, it is a thought process that involves the evaluation, assessment, and reinterpretation of one ideas and thought processes. Therefore, the ability to develop a well thought out solution within a reasonable time frame, is a skill that employers value greatly (Eggen and Kauchak, 2012). Thus, critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection and reasoning as a guide to belief and action (Ennis2015). In ideal form, it is based on universal intellectual values that transcend subject matter divisions, clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth and fairness. Critical thinking therefore, could be self-directed, self-disciplined, self-monitored, and self-corrective thinking (Clarke, 2019).

Problem solving is the result of critical thinking (Husamah and Setyaningrum, 2013). Problem solving involves discovering and analyzing the problem with the goal of finding the best possible solution to overcome the obstacle. In fact critical thinking requires a lot of attention and brain function. When a critical thinking approach is applied to technology and engineering, it helps the student's brain function better and understand texts differently. The following steps are essential in problem solving such as: identify the problem, define the problem, forming a strategy, organizing information allocating resources, monitoring progress and evaluating the results. However, to become a problem-solver, individuals' could learn the art of thinking critically and creatively. With the rapid changes in technology and engineering are face with new challenges continuously in the field of education. Consequently, Pinder-Grover, (2013) opined that critical thinking and problem-solving skills could help individuals' to:

- Improves flexibility and learning skills. With the evolutionary changes in technology, one has to learn and adapt faster to new environments and procedures. Critical thinking could help to be more flexible to changes.
- Reflect on their learning experiences and make effective decisions. With critical thinking, one may start considering all possible options for reaching a prospective solution.

Table 1. Framework for 21st Century Concepts

Framework 21st Century Skills	IP-21CSS	Aspect
Creativity Thinking and Innovation	4Cs	• Think creatively • Work creatively with others • Implement innovation • Use a wide range of idea creation techniques to create new and worthwhile ideas
Critical Thinking and Problem Solving		• Effective reasoning • Use a thinking style • Make judgments and decisions • Solve different kinds of non-familiar problems in both conventional and innovative ways. • Effectively analyze and evaluate evidence, arguments, claims and beliefs
Communication and Collaboration		• Communicate clearly • Collaborate with others • Articulate thoughts and ideas effectively • Demonstrate ability to work effectively
Information, Media and Technology Skills	ICTs	• Understand both how and why media messages are constructed; • Create media products by understanding and utilizing the most appropriate media creation tools, characteristics and conventions. • Use technology as a tool to research, organize, evaluate and communicate information. • Access and evaluate information critically and competently • Manage the flow of information from a wide variety of sources.
Life & Career Skill	Character Building	• Demonstrate the scientific behaviour of attitude (desire to be curious, honest, thorough, open and prudent) • Demonstrate acceptance of the moral values prevailing in society • Flexibility and adaptability • Initiative and self-direction • Social and cross-cultural skills • Productivity and accountability • Leadership and responsibility
	Spiritual Values	• Live the concept of God through science • Internalize spiritual values in everyday life

- Become more interactive if the teacher encourages them to think critically. With critical thinking, students can align their subjects with their own lives. In the process, learners become active participant in the whole learning process.
- Learn other important skills such as creativity, collaboration, and cooperation.
- Practice reasoning that helps one to overcome biases and prejudices.
- Enhance performance as you are self-directed in your learning and decision-making.
- Accommodate learning activities that could improve high-level thinking skills and better communication.

Communication competencies simply means the act of transferring information from one place to another. It may be vocally-using voice, written-using printed or digital media such as books, magazines, websites or emails, visually-using logos, maps, charts or graphs or non-verbally- using body language, gestures and the tone and pitch of voice (Valène and Kristina, 2020). In practice, it is most often a combination of several of these. Ability to communicate effectively is perhaps one of the most important of all life skills. It could enables us to pass information to other people, and to understand what is said to us. Communication tends to reduce the sense of isolation, and open access to knowledge and skills. This could be enhanced through the use of information and communication technology (ICT). ICT based educational delivery like educational programming broadcast over radio and television. It could provide access anytime and anywhere by making possible asynchronous learning. In addition, certain types of ICTs such as teleconferencing technologies could enable instructions to be received simultaneously by multiple, geographically dispersed learners. For example, articulate thoughts and ideas effectively.

Furthermore, using oral and written communication skills could be in variety of process. In other words, it involves both the sending and receiving of information. Thus, effective and efficient communication with better response from fellow students could facilitates quick problem solving, strong decision making, enhances productivity, eases consistence in the work flow, better control, advance professional image and promote better learning environment (Valène and Kristina, 2020). Thus, communication competencies are needed in almost all aspects of life especially in group discussion among students and teachers in a learning environment. However, good communication skills could improve the way that one operate through life, smoothing one way in relationships with others. Whereas, poor communication skills, on the other hand, can sour relationships from business to personal, and could make one's life significantly rigid and could be positive or negative collaboration competencies.

Collaboration competencies are the soft skills developed between individuals and teams in order to interact, engage, and synergize while working towards a common goal. There could be several skills that fall under this umbrella terms, such as communication group brainstorming, emotional intelligence, problem-solving, time management and critical thinking (Kolmar, 2011). Collaboration therefore is the qualities and abilities that allows one to work well with others during conversations, projects and meetings. For instance, in technical education workshop collaboration competencies could assist in the following reasons: students could acquire various soft skills, such as the ability to work in teams and to achieve objectives in cooperation with others; students learn to communicate with each other using technical expressions that are specific to their professional field; students learn to integrate the know-how of others in order to accomplish a given work task; and students acquire remote collaboration skills when teamwork is carried out from several locations simultaneously.

However, two basic aspects of collaboration may be important in this context. The first involves the relationship among students: students work together as peers, applying their combined knowledge to the solution of a problem. The dialogue that result from the combined effort allows students to test and refine their understanding in an ongoing process.

The second aspect of collaboration involves the role of the teacher: teachers should serve as moderators during the learning process by helping students to reflect on their evolving knowledge and by providing direction when students are having difficulties. Furthermore, collaboration could be boosted by using ICT, this strategy could be advantageous as the world becomes more interconnected. Nevertheless, collaboration competencies are essential to one success at work, no matter your industry or job title. Working well with colleagues and other people in workshop could help one complete tasks efficiently. Thus creating an enjoyable environment both for yourself and others. An organization that emphasizes good collaboration and teamwork skills would be healthy and high-functioning workplace to could enhance creativity and innovation.

Creativity/innovation competencies simply means thinking process that is concerned with producing ideas that are original and useful in solving problems (Stein and Harper, 2012). Creativity therefore is the ability to think about a task or a problem in a new or different way, or the ability to use the imagination to generate new ideas. Creativity could empowers one to solve complex problems or find interesting ways to approach tasks. If one is creative, one may look at things from a unique perspective. Thus creativity could be seen as the infinite source of innovation and innovation can be perceived as the application and implementation of creativity Buehlmann, (2014). The creative process is at the heart of innovation and often the words are used interchangeably Creativity is an active process necessarily involved in innovation. It is a learning habit that requires skill as well as specific understanding of the contexts. Accordingly, Odueyungbo, (2013) explained creativity as a fresh thinking and may involve deep factual knowledge and high levels of practical skill. It could also involves critical thinking as we need to make judgments about some things. It is a dynamic process involving refining, testing and focusing on what we are doing and also making connections across disciplines. Innovation on the other hand has been understood as the overview of a new or different ideas or methods. Innovative learning is problem-based learning that brings creativity to life. Innovation occurs when creative ideas and methods are applied to the betterment of previously created products. Therefore, creativity and innovative are fundamental to all academic disciplines and educational activities, not just the arts. Creativity and innovation abilities are very important to overcome the demands of the 21st century with a tendency to make conclusions based on evidence (Eggen and Kauchak, 2012). For example, to understand new concepts and broaden perspectives, our approaches to thinking need to be creative, imaginative and lateral incorporating new ways of looking at things, as well as linear using existing patterns of thought. Thus the teacher should be able to encourage the students to demonstrate imaginative to think out of the box and learn new things. Therefore, a creative teacher could makes the lesson interesting and interactive. He could transform the way students learn and how they will be able to apply it in real life situation. Also the teacher could improve the students' emotional as well as social skills such as think creatively, work creatively with others, implement innovation, and use a wide range of idea creation techniques to create new and worthwhile ideas (Subramanian, 2013). The mechanical/automobile industries in Nigeria require serious transformation in order to contribute more effectively to the economic growth in the 21st century. The working environment and operations of the mechanical/automobile industry need to be revolutionized, modernized, structured, organized and standardized to make it a more attractive and profitable technology development Arends, (2012). To achieve this both the professionals and nonprofessionals in the educational sector of the economy have to be creative and innovative. However, the mechanical/automobile workshops and their working environments lack good infrastructural and facilities. The sector is devoid of structural organization and administration. Its workforce perform operations without standard and lack due process of business ethics. Modern tools and equipment are lacking and the workers' carryout repairs of automobiles by trial and error probably because of to lack of diagnostic equipment.

Experiential learning activities therefore have become even more important especially in mechanical/automobile technology education due to changing times and the increasing pressure to produce graduates with 21st century competencies. Clark and White (2010) asserted that quality University mechanical/automobile technology programmes must include experiential learning components which can take many forms including practicums of all types such as simulated, on-campus, and distance; service learning or classes that are involved with industries such as the advertising class that designs advertisements for clients, or the computer classes that take on projects for small businesses.

In Nigeria, engineering and technology have been criticized on the grounds that it has not been able to produce practically competent graduates who are equipped with problem solving abilities. The major reason is as a result of poor and inadequate training facilities and equipment in the institutions. This has caused a negative effect on trainees. It is obvious that the higher institutions of learning in Nigeria find it difficult to produce models of machines or equipment similar to those used in the industries to prepare learners with skills needed by the industries. In this situation of limited or lack of modern equipment, thereby producing graduates lack the requisite skills technical skills. The problem of the study is that graduates lack the requisite competencies for developing 21stcentury workforce that will make them productive citizens. It is therefore imperative to study experiential learning activities required by students' of mechanical/automobile technology education for developing competencies for 21st century to see if students' overall productivity, resourcefulness, effectiveness and efficiency could improve before graduation for gainful employment in industries.

Statement of the Problem

The new knowledge age of this millennium is creating a globalized economy that requires a much more diverse range of technological skills and dispositions, yet many countries' education systems still promote an outdated industrial age model of teaching and learning. In Nigeria universities, teaching and learning process is short of providing basic learning experiences that could make the graduates become productive in the 21st century. The question now, what are the learning experiences that must expose the students so that on graduation they should able to demonstrate the requisite competencies which will make them employable citizens in the 21st century. Therefore 21st century competencies are absolutely essential and if technology teachers does not incorporate them in teaching and learning processes, it will not

only be outdated classroom, but also, it will be completely out of competition in the current world market. One of the goals and benefits of education management is the realization of an atmosphere of learning in an active, innovative, efficient and enjoyable learning process. Unfortunately, the objectives have not being achieved due to continual use of lecture-demonstration teaching method in our tertiary institution. Therefore, it become necessary to examine the experiential learning activities of mechanical/automobile technology education students for developing competencies for 21st century across different levels of academic instruction in a public university in Anambra State, Nigeria. To see if low level skills performance of students could be enhance by exposing them to experiential learning activities to acquire requisite competences of 21st century.

Purpose of the study

The purpose of this study was therefore to identify those experiential learning activities in which the students' of mechanical/automobile technology programme should be expose to so that they could be able to demonstrate competencies necessary for developing the 21st century. Specifically, the study was focused on the:

- Experiential learning activities for developing critical thinking/problem solving competencies required by students' in mechanical/automobile technology education.
- Experiential learning activities for developing communication competencies required by students' in mechanical/automobile technology education.
- Experiential learning activities for developing collaboration competencies required by students' in mechanical/ automobile technology education.
- Experiential learning activities for developing creativity/innovation competencies required by students' in mechanical/ automobile technology education.

Research questions

The following research questions guided the study:

- What experiential learning activities are required by students' in mechanical/automobile technology education for developing critical thinking/problem solving competencies?
- What experiential learning activities are required by students' in mechanical/automobile technology education for developing creativity/innovation required competencies?
- What experiential learning activities are required by students' in mechanical technology education for developing communication competencies?
- Experiential learning activities are required by students' in mechanical/ automobile technology education for developing collaboration competencies.

Hypotheses

The following two null hypotheses guided the study and was tested at 0.5 level of significant:

- There was no statistically significant differences in the experiential learning activities needed by students' in mechanical/automobile technology education for developing critical thinking/problem solving competencies across different levels of academic instruction.
- There was no statistically significant differences in the experiential learning activities required of students' in mechanical/automobile technology education for developing creativity/innovation competencies across different levels of academic instruction.

METHODS

The study was a descriptive survey. The full time students' in mechanical/automobile technology in public university in Anambra State, Nigeria, were used for the study. In Nigerian university students admitted through the Unified Tertiary Matriculation Examination (UTME) who were admitted into full-time academic programme. The total number of registered full-time mechanical/automobile technology students comprises of 250 as at 2019/2020 academic session. The entire population were used without sampling. A structured questionnaire was constructed for data collection. The 94-items questionnaire involved questions about individual level of academic instruction and items related to the research questions. The instrument employed a five-point rating scale of: Very Highly Required (VHR ¼ 5 points); Highly Required (HR ¼ 4 points); Moderately Required (MR ¼ 3 points); Required (R ¼ 2 points); Not Required (NR ¼ 1 point. The instrument was validated by four experts in mechanical/ automobile, Department of Technology and Vocational Education. The internal consistency determined using Cronbach's alpha reliability technique which yielded a coefficient of 0.78.

The questionnaire was administered online with the help of four departmental lectures (research assistants). A total number of 250 mechanical/automobile technology students corresponding to 72% rate of return responded to all the items and were therefore used for data analysis(see table 1). Mean and standard deviation were used to answer the research questions. The Kruskal–Wallis Test of significant difference at 0.05 level of significance was used to test the hypotheses. The data was analyzed using Statistical Package for the Social Sciences (SPSS). The decision rule for the research questions was that any item with a mean rating of above 3.00 above would be regarded as 3.00 highly required while any mean score below 3.00 would be moderately required. The hypotheses tested at 0.05 level of significance were accepted where $p > 0.05$ and rejected where $p < 0.05$

Demography of the students

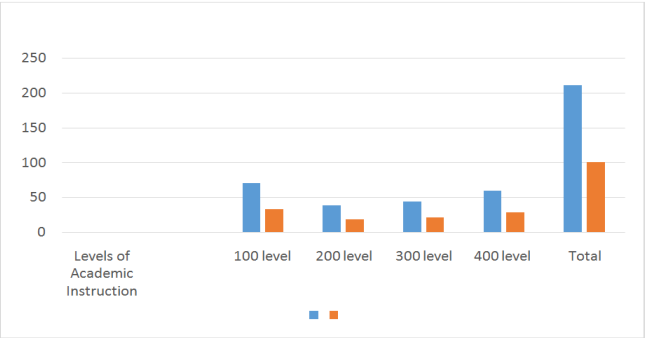

Figure 3. Bar charts showing the demography of the students across various level of instruction

Table 1. Mean and standard deviation of the responses on the experiential learning activities required by students' inmechanical/automobile technology education for developing critical thinking and problem solving competencies for 21st century

N =211

S/No	Experiential Learning Activities	Mean	SD	Remarks
1	Ability to identify minor faults on lathe machines	4.86	0.40	HR
2	Ability to rectifying faults and replace with new parts	4.10	0.82	HR
3	Understanding procedure in loosing bolt and nuts	4.77	0 .82	HR
4	Take mental picture of tool and equipment for maintenance and repairs	4.48	0.59	HR
5	Ability to diagnose the actual causes for engine misfiring, troubleshooting and breakdown	4.46	0.62	HR
6	If the parts is not replaced now, what will be the end results to engine/ machine performance	4.04	0.69	HR
7	Being able to ask question during problem solving in practical classes	3.99	0.86	HR
8	Competencies to gather and draw conclusion based on the actual causes of problems in motor vehicle	4.04	0.69	HR
9	Proficiencies to extrapolate and discover potential outcomes in solving real life situation.	3.89	0.86	HR
10	Ability to guess in problem solving technique e.g. services, maintenance and repairs of machines/engine	4.03	0.76	HR
11	Draw warranted conclusion on issues and generalization at which one arrives at the solution	4.45	0.57	HR
12	Use logical reasoning ability on how to improve machine/engine efficiency and productivity	4.31	0.86	HR
13	Capability to gather and marshal pertinent and useful information from the manufacturing manual during services and repair	4.46	0.64	HR
14	Skills in selecting right tools, consumablematerials for practical work.	3.65	0.77	HR
15	Carefully and systematically follow rules in fitting exercise	3.98	0.76	HR
16	Use simulations model relating to learning contents	4.46	0.6	HR
17	Ability to accomplish self-directed projects	4.06	0.56	HR
18	Make sound, and critical decisions.	3.58	0.86	HR
19	Ability to relate theory and practice effectively	4.51	0.67	HR
20	Use observation, experience, reflection and reasoning skills	3.68	0.67	HR
21	Ability to synthesize and/or evaluate information gathered	3.99	1.56	HR
22	Involved in industrial attachment to practice in companies	3.67	.073	.HR
23	.Willing to tackle challenging tasks, even when success is uncertain	4.42	.062	HR
24	Able to solve problem either individually or in group.	4.78	.083	HR

Note: Very Highly Required (VHR); Highly Required (HR); Moderately Required (MR); Required(R); Not Required (NR).

Table 2. Mean and standard deviation of the responses on the experiential learning activities required by students' in mechanical/automobile technology education students' for developing communication competencies for 21st century

N= 211

S/No	Experiential Learning Activities	Mean	SD	Remarks
1	Use language with accuracy, clarity and during group discussion	4.54	0.71	HR
2	Exhibits good listening abilities.	4.66	0.86	HR
3	Quick problem solving competencies	4.51	0.61	HR
4	Able to interact effectively with a variety of individuals and groups verbally and no-verbally	4.06	0.65	HR
5	Develop open mind tolearn and benefit maximally	4.20	0. 84	HR
6	Understand terms such as media, multimedia, hypermedia, clip media etc.	4.17	0. 99	HR
7	Strong decision making aptitudes	4.47	0. 50	HR
8	Give feedback with text message easily	3.33	0.72	HR
9	Operate a computer/ fax machine and cameras	3.55	0. 98	HR
10	Communicates through e-mail, phone, text message, WhatSapp, Instagram and Twitter etc.	4.61	0 57	HR
11	Ability to use writing skills and presentation skills	4.76	0.46	HR
12	Use of body language and systems engineering	3.00	0.76	HR
13	Goal setting intelligently and achieve it	4.07	0.38	HR
14	Employ peer tutoring and peer assessment strategy	4.09	0.45	HR
15	Use of computer simulation and video based activities	4.35	0 54	HR
16	Create simple animations and games to support learning	4.24	0.34	HR
17	Essentialcommunication competencies know-hows	4. 36	0.77	HR
18	Consistence in the work flow with others	4.28	0.67	HR
19	Ability to influence persuasion skills within group discussion	4.03	0.56	HR
20	Possess strong business physical characteristics	4.13	0.67	HR
21	Use Word, Excel, coral draw and AutoCAD	4.67	0.46	HR

Note: Very Highly Required (VHR); Highly Required (HR); Moderately Required (MR); Required (R); Not Required (NR).

PRESENTATION OF RESULTS

Research Question 1

What are the experiential learning activities needed by students' in mechanical/automobile technology education for developing critical thinking and problem solving competencies for 21st century?

Table 1 shows that the mean ratings for the 24 items ranged from 3.65 and 4.86 are highly needed. This means that the students required critical thinking and problem solving competencies to performed and function efficiently in present information age. The standard deviation of 0.61 And 1.07 shows that the respondents were relatively heterogeneity in their mean ratings. It is expected that students should effective reasoning, use a thinking style, make judgments and decisions as well as solve different kinds of non-familiar problems in both conventional and innovative ways. Furthermore, they should effectively analyze and evaluate evidence, arguments, claims and beliefs.

Research Question2

What are the experiential learning activities needed by students' in mechanical/ automobile technology education for developing communication competencies for 21st century?

Table 2 shows that the mean ratings for the 21 items ranged from 3.00 and 4.47 are highly needed. This means that the students required communication competencies to performed and function efficiently in the world of work. The standard deviation of 0.34 and 0.98 shows that the respondents were reason ably homogeneity in their mean ratings. Thus students

must collaborate with others and fluent thoughts in the way of working, tools for working and living in the world.

Research Question 3

What are the experiential learning activities for developing collaboration competencies needed by students' in mechanical/ automobile technology education for developing 21st century?

Table 4 shows that the mean ratings for the 21 items ranged from 3.51and 4.60 are highly required. This indicates that the students needed the collaborative competencies to performed excellently well in 21st century world of work. The standard deviation of 0.56 and 0, 86 shows that the respondents were comparatively homogeneity in their mean ratings. Therefore, students are expected to communicate clearly, articulate thoughts and ideas effectively and demonstrate ability to work effectively.

Research Question 4

What experiential learning activities needed bystudents' in mechanical/ automobile technology education for the development of creativity/innovation competencies?

Table 5 shows that the mean ratings for the 28 items ranged from 3.83 and 4.48. This also shows that the students needed the competencies to performed and function efficiently in 21st century.

The standard deviation of 0.61 and 0.96 shows that the respondents were relatively heterogeneity in their mean ratings. The students ought to think creatively, work creatively with others, implement innovation and use a wide range of idea creation techniques to create new and worthwhile ideas are highly needed.

Table 3. Mean and standard deviation of the responses on the experiential learning activities required by students' in mechanical/automobile technology education students' for the development of collaboration competencies for 21st century

N =211

S/No	Experiential Learning Activities	Mean	SD	Remarks
1	Criticize ideals constructively not people and have self-confidence, self-control and social skills	4.70	0.46	HR
2	Display respect for themselves and their team regardless of other peoples diversity and individual differences	3.96	0.67	HR
3	Emotional intelligence skills	3.97	0.82	HR
4	Interpersonal relationship abilities	3.92	0.74	HR
5	Marketing skills for self-employment	4.51	0.62	HR
6	Exercise group brainstorming expertise	3.82	0.56	HR
7	Transferable knowledge ability	3.62	0.71	HR
8	Being creative / innovative approach	3.51	0.70	HR
9	Ability to complete a task with groups	3.71	0.76	HR
10	Employable skills need by industries	4.60	0.72	HR
11	Exhibit flexibility /adaptability skills	3.88	0.78	HR
12	Remind others to employ collaborative skills	4.77	0.83	HR
13	Ignore distraction and take responsibility	3.61	0.61	HR
14	Knowledgeable in computer technology	4.72	0.83	HR
15	Expert in technical skills	3.82	0.76	HR
16	Confliction resolution/deescalating skills	3.55	0.82	HR
17	Time management and /organizational skills	4.02	0.86	HR
18	Asking questions and listen to others contributions	4.28	0.78	HR
19	Genuine rapportskills	4.16	0.71	HR
20	Displaying networking skills	4.20	0.79	HR
21	Efficient and exhibit good working attitude	4.67	0.78	HR

Note: Very Highly Required (VHR); Highly Required (HR); Moderately Required (MR); Required (R); Not Required (NR).

Table 4. Mean and standard deviation of the responses on the experiential learning activities required by students' in mechanical/automobile technology education students' for the development of creativity/innovation competencies for 21st century

N =211

S/No	Experiential Learning Activities	Mean	SD	Remarks
1	Ability to generate new methods and ideals	4 .48	0.23	HR
2	Ability to exercise manipulative skills with strength	4.18	0.66	HR
3	Demonstrates learning that requires skill and practice	4.35	0.70	HR
4	Appreciates and value creation abilities	4.38	0.01	MR
5	Possess resilience spirit and flexibility	4.26	0.61	HR
6	Ability to look at things from different perspectives	4.32	0.51	HR
7	Critically evaluating teamwork at appropriate points	4.26	0.63	HR
8	Make inquiring when the need arises for improvement of products	4.45	0.61	HR
9	Effective planning with good approach to use	4.18	0.63	HR
10	Notice connections between seemingly subject matter	3.83	0.93	HR
11	Scaffolding tasks carefully	2.48	0.84	MR
12	Ability to tolerate uncertainty and preserve at a task to overcome obstacles	3.95	1.07	HR
13	Recognize alternative possibilities	3.50	0.91	HR
14	Participate in creative thinking exercise	4.55	0.64	HR
15	Strong negotiating skills,	4.03	0.61	HR
16	Appreciating the critical importance of intelligent question	4.87	1.64	HR
17	Engage in deep reflective thinking	4.67	1.84	HR
18	Introduce entrepreneurship new thinking and ideals	4.02	1.67	HR
19	Ability to exercise manipulative skills development	4.34	0.72	HR
20	Application of abstract conception to concrete conception	4.12	0.35	HR
21	Willingness to take sensible risks or go out of their comfort zone in their work	3.56	0.14	HR
22	Embracing the culture of innovation and technology	4.12	0,12	HR
23	Role modelling creative habits	3.47	0.23	HR
24	Find multiple ways of solving problem	35.0	0.43	HR
25	Use and apply various technologies in the workplace.	4.45	0.12	HR
26	Apply occupational health and safety knowledge to appropriately use technology	4.74	1.89	HR
27	Continually expand capacity through learning, modified their behaviours to reflect new knowledge and insights.	4.45	1.25	HR
28	Able to interpret, create and illustrate ideas using charts, tables and graphs.	4.56	1.45	HR

Note: Very Highly Required (VHR); Highly Required (HR); Moderately Required (MR); Required (R); Not Required (NR).

Table 5. Summary of the Kruskal–Wallis Test analysis of significant differences on the experiential learning activities needed by students' in **mechanical/automobile education for developing critical thinking/ problem solving skill scompetencies across different levels of academic instruction**

S/No	Experiential Learning Activities	Chi –Square	p- Value	Remarks
1	Ability to identify minor faults on lathe machines	24.6	.000	S
2	Ability to rectifying faults and replaced with new parts	17.86	.001	S
3	Understanding procedure in loosing bolt and nuts	23.79	.004	S
4	Take mental pictures of tools and equipment for maintenance and repairs	17.67	.003	S
5	Ability to diagnose the actual causes of engine misfiring, troubleshooting and breakdown	14.30	.004	S
6	If the parts is not replaced now, what will be the end results to engine/ machine performance	14.89	.004	S
7	Being able to ask question during problem solving in practical classes	24.90	.003	S
8	Ability togather and draw conclusion based on the actual causes of problems in motor vehicle	15.56	.002	S
9	Ability to generalize and discover potential outcomes in solving real life situation.	14.47	004	S
10	Ability to predictswhen machines/engine needs service and maintenance	3.10	.002	S
11	Draw warranted conclusion on issues and generalization at which one arrives at the solution	14.83	.004	S
12	Use logical reasoning ability on how to improve machine/engine efficiency and productivity	16.94	.001	S
13	Use pertinent and useful information from the manufacturing manual during services and repairs	12.70	.003	S
14	Skills in selecting right tools, consumable materials for practical work	24.7	.000	S
15	Carefully and systematically follow rules in fitting exercise and machining work	21.50	.001	S
16	Use simulations model relating to learning contents	18.06	.004	S
17	Ability to accomplish self-directed projects	10.50	.002	S
18	Peer assess results of team and individual work	4.60	.004	S
19	Ability to relate theory and practice effectively	20.64	.001	S
20	Use observation, experience, reflection, reasoning skills	17,20	.003	S
21	Ability to synthesize, and/or evaluate information gathered	4.56	.002	S
22	Involved in industrial attachment to practice in companies	25.67	.003	S

Note: S=Significant, NS =Not Significant)

Table 6. Summary of the Kruskal–Wallis Test analysis of significant differences on the experiential learning activities required by students' mechanical/automobile fordeveloping creative/innovation skills competencies across different levels of academic instruction

S/No	Experiential Learning Activities	Chi –Square	P- Value	Remarks
1	Ability to generating new methods and ideals	21.50	.000	S
2	Ability to exercise manipulative skills with strength	24.7	.001	S
3	Engage in learning that requires skill and practice	24.6	.004	S
4	Value design and manufacturing	17.86	.003	S
5	Resilience spirit and flexibility	23.79	.004	S
6	Critically look at things from different perspectives	30.67	.004	S
7	Critically evaluating work at appropriate points	14.30	.002	S
8	Make inquiring when the need arises for improvement of products	43.89	.002	S
9	Effective planning which approach to use	42.90	.000	S
10	Notice connections between seemingly subject matter	32.56	.004	S
11	Scaffolding tasks carefully	14.47	.001	S
12	Ability to tolerate uncertainty and preserve at a task to overcome obstacles	23.10	.000	S
13	Recognize alternative possibilities	24.83	.001	S
14	Involve in original thinking activities	26.94	.004	S
15	Strong negotiating skills,	12.70	.003	S
16	Appreciating the critical importance of question	34.06	.000	S
17	Deep reflective thinking activities	26.17	.000	S
18	Inventiveness in the workshop	23.08	.000	S
19	Manipulative skills development	32.14	.000	S
20	Abstract conception to concrete conception	34.12	.000	S
21	Willingness to take sensible risks or go out of their comfort zone in their work	17.08	.000	S
22	Embracing the culture of novelty and technology	24.74	.00I	S
23	Role modelling imaginative habits	28.01	.004	S
24	Find multiple ways of solving problem	23.75	.002	S

Note: S=Significant, NS =Not Significant)

Hypotheses 1

There was no statistically significant differences in the experiential learning activities needed bystudents' inmechanical/ automobile technology educationfor developing critical thinking and problem solving competencies across different levels of academic instruction

Table 5 shows that there was no significant difference between levels of academic instruction and the seven EL activities required for the development of critical thinking and problem solving competencies. These activities have p-value ranging from p ¼ 0.000 to 0.004 (that is $p < 0.05$). The null hypotheses were therefore rejected since there was a statistically significant difference between various levels of academic instruction employing EL activities could enhance development of critical thinking competencies.

Hypothesis 2

There was no statistically significant differences in the experiential learning activities required by students' in mechanical/automobile for developing creativity and innovation competencies across different levels of academic instruction.

The results of the Kruskal–Wallis Test of significance in Table 6 shows that there were no statistically significant differences between levels of academic instruction in seven out of the fifteen EL activities mentioned in the study for the development of creativity and innovation competencies (since the p-value ranged from p ¼ 0.000 to 0.004, that is $p < 0.05$). The null hypotheses were therefore rejected since there was a statistically significant difference between various levels of academic instruction using the EL activities could improve students' creative and innovative.

DISCUSSION

The study comprises of 211 respondents from different levels of academic instruction as shown in table 1. It shows larger population of mechanical/automobile technology students in hundred level (33%), two hundred level (28%), three hundred level (21%) and four hundred level (18%) respectively. See figure 3 showing the demography of the students in pie chart

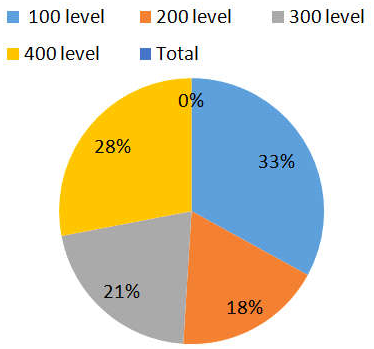

Fig. 3. Pie Chart Showing the Demography of the students

Table 1 shows that the mean ratings for the 21 items ranged from 3.65 and 4.86, which simply means that they were highly required. Thus the students required critical thinking and problem solving competencies to perform and function efficiently in present information age. The standard deviation of 0.61 and 1.07 shows that the respondents were relatively heterogeneity in their mean ratings. This was indeed expected because students from different levels of academic instruction participated in the study. This result supported the notion that Buehlmann, (2014), stated that the number of student failures in receiving information is due to the incompatibility of teacher teaching styles with student learning styles. Thus, teachers in teaching should pay attention to students' diverse learning styles. Based on the characteristics and principles of technology education and curriculum must be process oriented in the form of learning experiences and activities in schools and products. The results of learning experiences and activities. The results also show that the students were required to engage in activities such as industrial attachment, which could promote their critical thinking and problem solving competencies. Mechanical/automobile technology students however undergo one year Students Industrial Work Experiences Scheme (SIWES) in their two hundred; in line with Stein and Harper, (2012) findings that learning experiences acquired from supervised industrial work experience have a significant effect in enhancing students' knowledge, skills and work attitude. However, judging from the high standard deviation of the item, it appears that students in other levels of academic instruction apart from the three hundred level students, do not get to practice in companies.

Table 2 shows that the mean ratings for the 21 items ranged from 3.00 and 4.47 are highly needed. This means that the students required communication competencies to performed and function efficiently in the world of work. The standard deviation of 0.14 and 0.98 shows that the respondents were reasonably heterogeneity in their mean ratings. This was to be expected because students from different levels of academic instruction participated in the survey. This suggests that students from different levels of academic instruction required to active engagement in different set of EL activities such as maintaining positive attitudes, listening, writing, interpersonal, and verbal/ body language skills and sharing creative ideas and solving problems**.** According to the finding of Valène and Kristina, (2020) stated that learning experiences acquired from supervised industrial work experience in companies and establishments have a significant influence in improving students' communication skills and interaction with the general public.

Table 3 shows that the mean ratings for the 20 items ranged from 3.51and 4.60 are highly required. This indicates that the students needed collaborative competencies to performed excellently well in 21st century world of work. The standard deviation of 1.61 and 2.01 shows that the respondents were comparatively heterogeneity in their mean ratings. This was expected because students from different levels of academic instruction participated in the study. The result from the finding shows that students were really involved in EL activities such as decision making process, communication skills, give feedback, group brainstorming, active listening, diplomacy, emotional intelligence, problem-solving, team work skills, time management/organizational skills, conflict resolution/ deescalating, network skills and critical thinking skills etc. Accordingly, the findings of Kolmar, (2011) stated that learning experiences developed from Students Industrial Work Experiences Scheme in companies and establishments have a significant influence in improving students' collaborative competencies in 21st century.

Table 4 shows that the mean ratings for the 29 items ranged from 3.83 and 4.48. This also shows that the students needed creative and innovative competencies to performed and function efficiently in 21st century. The standard deviation of 0.61 and 0.96 shows that the respondents were relatively heterogeneity in their mean ratings. This was really expected because students from different levels of academic instruction participated in the survey. The findings of Odueyungbo, (2013) stated that practical experiences developed from workshop experience in companies and establishments have a significant effect in improving students' collaborative competencies in 21st century.

Table 5 shows that there was no significant difference between levels of academic instruction and the seven EL activities required for the development of critical thinking and problem solving competencies. These activities have p-value ranging from p 0.000 to 0.004 (that is $p < 0.05$). The null hypotheses was therefore rejected since there was a statistically significant difference between levels of academic instruction and the EL activities required the development of critical thinking and problem solving competencies. The descriptive analysis shows that students in higher levels of academic instruction (year one and year two students) acknowledged their engagement in most of the activities. There was no significant difference between 100 and 200 level students in all of the EL activities. This finding is consistent with the mechanical/automobile curriculum of Nigerian University where students are required to undergo one year Students Industrial Work Experiences Scheme (SIWES) before their graduation in the course of study. Hence, 100 and 200 level students may not have the opportunity to practice in industries and engage in serious practical activities that could enhance critical thinking and problem solving competencies in a formal setting. This result verifies that the findings of Hien and Oanh, (2018) who discovered that the more exposure the students, the more experiential learning activities they might acquire in

developing competencies for 21st century as well as their overall professional capability. What can be inferred from the above statement is that the new policy places a high stake on continuous growth and development of teachers generally through systematic training and industrial experience. However, most of our course designs apparently either failed to clarify or lost sight of the direction which such training might take to enhance the industrial experience of the teacher and in consequence, his ability to ingrain acceptable work ethics in the students Table 6 shows that there were no statistically significant differences between levels of academic instruction in seven out of the fifteen EL activities mentioned in the study for the development of creativity and innovation competencies (since the p-value ranged from p ¼ 0.000 to 0.004, that is $p < 0.05$). The null hypotheses were therefore rejected since there was a statistically significant difference between various levels of academic instruction using the EL activities could improve students'. The students have to engage in creative thinking, work artistically with others, implement innovation and use a wide range of idea creation techniques to generate new and worthwhile ideas are highly needed.

Conclusion

Based on the findings of the study, it was concluded that mechanical/ automobile technology students are expected to engage in experiential learning activities for the development of critical thinking/ problem solving, communication, collaboration and creative / innovative competencies for 21stcentury. However, 100 and 200 levels students could not engaged in experiential learning activities because the curriculum of study did not specify the need for SIWES and industrial linkage between the university undergraduates and industries for the development of 21_{st} century competencies in comparison to 300 and 400 level that undergo SIWES in industries related to their area of specialization. The results of this study have significant implications for the teaching and learning of mechanical /automobile technology particularly in developing countries. It provides insight into the activities that are already incorporated in technology education and also highlights areas that require further improvement. Thus graduate students with strong 21st century competencies, mechanical/automobile technology programmes should be deeply rooted in experiential learning activities and become skillful and productive. And may perhaps contributes immensely to the economic growth and development of the nation.

Recommendations

Based on the findings of the study, the following recommendations were made:

- There should be curriculum revision to include experiential learning activities in all the university level of education
- Nigeria university lecturers should devote a substantial proportion of teaching and learning time to experiential learning activities, such as, concrete experience, reflective observation, abstract conception, and active experimentation.
- Tertiary institutions should establish industrial collaborations and strengthen partnerships between schools and industries in order to create avenues for technology education students at all levels to engage in experiential learning and skills in real life situations.
- University education should place more emphasis on practical /technical skills acquisition that would make graduates self-reliance and self-sufficient and not job seekers.
- Standardized practical examination should be organize to the students before issuing certificate. For example, Trade Test for National Technical Certificate /Modular Examination. This would help in developing competencies for the 21st century as well as students overall professional capability.

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