# EFFECTIVENESS OF THE INNOVATIVE AUTOMOTIVE AIR-CONDITIONING SYSTEM LEARNING PACKAGE TO ENHANCE STUDENTS' ACADEMIC PERFORMANCE

**Azul De Leon Lacson, Ed.D.**
Zamboanga Peninsula Polytechnic State University
RT Lim Boulevard Baliwasan, Zamboanga City
Email address: lacsonazul50@gmail.com

***ABSTRACT:*** *Despite the importance of instructional materials in technical education, there is a lack of structured and interactive learning packages tailored for automotive air-conditioning systems. This study aimed to develop and evaluate the effectiveness of an innovative learning package designed to enhance students' academic performance in automotive air-conditioning competencies. Using a one-group pre-test and post-test design, the study was conducted at Zamboanga Peninsula Polytechnic State University. The respondents included automotive technology students who utilised the learning package and faculty experts who assessed its acceptability. Data were collected using a validated questionnaire, including pre-test and post-test scores. The results indicated that the learning package was highly acceptable across four components: Information Sheet, Learning Outcomes, Task Sheet, and Performance Criteria. Furthermore, a paired samples t-test analysis revealed a statistically significant improvement in students' post-test scores ($t(39) = -24.15$, $p < .001$), confirming the package's effectiveness in enhancing academic performance. The structured design, integration of hands-on applications, and competency-based approach contributed to the positive learning outcomes. Future research should employ a randomised controlled trial and longitudinal studies to further validate these findings. Additionally, curriculum enhancements may integrate structured learning packages, digital simulations, and continuous faculty training to strengthen competency-based education.*

**Keywords:** Academic Performance, Automotive air-conditioning, Competency-based learning, Instructional materials, Learning package, Quasi-experimental design

## 1. INTRODUCTION

The academic performance of students in any laboratory classes is significantly affected by the availability and quality of instructional materials used in practical learning environments. A lack of adequate instructional materials in automotive laboratories limits students' ability to acquire hands-on experience, leading to gaps in knowledge and technical skills [1]. In automotive air-conditioning systems, where troubleshooting and repair require precision and application of theoretical concepts, insufficient learning resources can hinder students' competency development [2]. Consequently, students often struggle with mastering essential skills, which can lead to poor academic outcomes and reduced employability in the automotive industry [3]. Without addressing this issue, the gap between industry demands and students' technical proficiency will continue to widen, potentially affecting the quality of graduates entering the workforce.

The absence of a structured learning package specifically designed for automotive air-conditioning systems presents a critical challenge in technical education. Traditional instructional approaches often rely heavily on lectures and textbook-based learning, which fail to provide students with adequate exposure to real-world applications [4]. Without hands-on learning tools, students may develop a superficial understanding of key concepts, leading to difficulties in applying knowledge in actual work settings [1]. Furthermore, research has shown that experiential learning, facilitated by well-designed instructional materials, significantly enhances students' comprehension and retention of technical knowledge [5, 6]... Therefore, there is a pressing need to integrate innovative instructional strategies, such as a structured learning package, to bridge the gap between theory and practice in automotive air-conditioningeducation.

A well-structured learning package has the potential to transform the educational experience of students by providing a comprehensive, interactive, and competency-based learning approach. Studies indicate that students learn more effectively when engaged in active learning environments that incorporate multimedia resources, hands-on activities, and step-by-step guidance [7, 8, 9]. Learning packages facilitate the systematic acquisition of knowledge and skills, ensuring that students are well-prepared for industry requirements [4, 10] Moreover, such instructional materials promote self-directed learning, allowing students to progress at their own pace while reinforcing key technical competencies [3]. The development of an innovative learning package for automotive air-conditioning systems is, therefore, a strategic intervention to address the deficiencies in existing teaching methodologies and enhance students' academic performance.If this challenge remains unresolved, students will continue to experience difficulties in grasping essential concepts, ultimately leading to lower academic achievement and skill deficiencies. The automotive industry demands highly skilled professionals capable of troubleshooting, diagnosing, and repairing air-conditioning systems efficiently [11, 12]. Without proper training resources, graduates may struggle to meet industry expectations, which can negatively impact their career prospects and job placement rates [3, 13]. Additionally, technical education institutions risk producing graduates who are inadequately prepared for employment, thereby affecting the overall reputation of the academic program [14, 15]. Thus, developing an innovative learning package tailored to automotive air-conditioning systems is imperative to equip students with the necessary knowledge, skills, and competencies.To address these concerns, this study seeks to answer the following research questions:

1. What is the level of students' acceptance of the developed learning package in automotive air-conditioning systems?
2. What is the level of students' academic performance in automotive air-conditioning systems before and after the implementation of the training package?
3. Is there a significant improvement in the students' academic performance in automotive air-conditioning systems after the implementation of the training package?

## METHODOLOGY

### *Research Design*

This study employed a one-group pretest-post-test research design, as described by Campbell and Stanley [16], which is

appropriate for evaluating educational interventions. This research design was selected because it allows for the comparison of student performance before and after the implementation of the learning package, making it suitable for real-world classroom settings [17]. This design ensures that the effectiveness of the developed learning package is measured in a structured manner, providing empirical evidence on its impact on the academic performance of the students. Furthermore, this approach is widely used in educational research to assess the efficacy of instructional tools in improving learning outcomes [18, 19]. Given the necessity of hands-on learning in technical fields like automotive technology, this research design aligns well with the study's objectives.

***Target Population, Sample and Sampling Procedure***

The target population of this study consisted of Bachelor of Science in Automotive Technology (BSAT)students at Zamboanga Peninsula Polytechnic State University. This population was selected due to their direct engagement with automotive air-conditioning systems, making them the most relevant group for evaluating the effectiveness of the learning package [20]. Given that automotive air-conditioning is a specialized field requiring both theoretical knowledge and hands-on skills, this study focused on third-year students enrolled in courses related to automotive air-conditioning systems. By focusing on this population, the study aims to provide insights that are directly applicable to the enhancement of automotive technology education [21]. Additionally, the inclusion of this specific population ensures that findings will be relevant for future improvements in instructional materials within the institution [22].

The participants in this study were divided into two groups: experts who evaluated the acceptability of the learning package and the BSAT students who utilized the package to improve their academic performance in automotive air conditioning.To assess the acceptability of the learning package, 20 experts in automotive air conditioning were purposefully selected based on their expertise and years of experience. These experts are employed across various sectors, including Technical Education and Skills Development Authority (TESDA), and academia.

For the student participants, a purposive sampling technique was employed to ensure that only those enrolled in automotive air conditioning courses were included.

**Table 1**, **Demographic Profile of the Expert valuators of the Learning Package**

| Variables | F | % |
|---|---|---|
| ***Expert Evaluators*** | | |
| Employment | | |
| TESDA | 10 | 50 |
| Academe | 10 | 50 |
| Years of Work Experience | | |
| Less than 5 years | | |
| 6 to 10 years | 1 | 5 |
| 11 to15 years | 15 | 75 |
| 16 to 20 years | 4 | 20 |
| More than 20 years | | |
| Sex | | |
| Female | 3 | 15 |
| Male | 17 | 85 |
| Qualifications | | |
| National Certificate | 10 | 50 |
| Trainer's Methodology | 10 | 50 |

The sample consisted of 40 third-year students who were enrolled during the second semester of the academic year 2022-2023. Students enrolled in this course during the data collection were all males, with age ranging from 20 to 23 years olds. Selecting participants from the same academic background helped maintain consistency in the study's findings [23]. Table 1 presents the demographic profile of the expert evaluators of the learning package utilized in this study. Table 1 presents the demographic profile of the expert evaluators of this study.

***Research Instrument***

The research instrument used in this study consisted of a structured pre-test and post-test, as well as a survey instrument to assess the acceptability of the learning package. The pre-test and post-test were designed to evaluate students' knowledge and practical skills in automotive air-conditioning systems before and after exposure to the learning package. The test items were developed based on the course syllabus and training regulations set by the Technical Education and Skills Development Authority (TESDA). The instrument was divided into two sections: the first section gathered demographic information such as name, department, academic rank, and length of service, while the second section focused on four key indicators—Information Sheet, Learning Outcomes, Task Sheet, and Performance Criteria—making up a total of twelve questions. To ensure validity, the test items were reviewed by a panel of experts in automotive education and instructional design [24]. A four-point Likert-scale survey instrument was used to measure the level of acceptability of the learning package, with 1 being Not Acceptable, and 4 being Highly Acceptable.

***Data Collection and Analysis***

Data collection was carried out over a period of six weeks. The pre-test was administered to both groups at the beginning of the study to establish baseline knowledge. After the instructional period, a post-test was administered to the students to measure the improvement in academic performance. The acceptability survey was distributed to the industry and academic experts to gauge perceptions regarding the instructional design and usability of the learning package.

Data analysis involved both descriptive and inferential statistics. Mean scores and standard deviations were computed to describe the students' Academic Performance before and after the intervention, and for the assessment of the acceptability of the learning package. A paired t-test was used to determine significant differences in pre-test and post-test scores within each group [25]. Table 2 shows the range of values as basis for evaluation of the level of acceptability of the learning package, and Table 4 for the level of Academic Performance.

**Table 2, Range of Values for Assessing Acceptability of the Learning Package**

| Scale | Range | Description |
|---|---|---|
| 1 | 1.01-1.75 | Not Acceptable (NA) |
| 2 | 1.76-2.50 | Somewhat Acceptable (AA) |
| 3 | 2.51-3.25 | Moderately Acceptable (MA) |
| 4 | 3.26-4.00 | Highly Acceptable (HA) |

***Development of the Learning Package***

The Automotive Air-Conditioning System Learning Package was developed as an instructional tool designed to enhance students' understanding of key concepts and skills in automotive air-conditioning systems. The package consists of four key components: Information Sheet, Learning Outcomes (L.O.s), Task Sheet, and Performance Criteria. These components collectively provide a structured approach to

bridging the gap between theoretical instruction and hands-on application [26].The Information Sheet serves as the foundation for knowledge acquisition, presenting fundamental concepts, technical details, and industry standards relevant to automotive air-conditioning systems. It is designed to facilitate comprehension through clear explanations, diagrams, and real-world applications. The Learning Outcomes outline the specific competencies students are expected to develop upon completing each module, ensuring alignment with industry expectations and curriculum requirements [27]. The Task Sheet provides step-by-step procedural guides that enable students to engage in hands-on activities, reinforcing theoretical knowledge through experiential learning. These activities include system diagnostics, troubleshooting, component assembly, and performance assessments, all aimed at developing students' cognitive and psychomotor skills. Additionally, the Performance Criteria establish benchmarks for evaluating student progress, ensuring that learning objectives are met and industry competencies are acquired [28].The learning package also includes additional features such as self-paced learning modules, formative assessments, and interactive quizzes, which allow students to reinforce and assess their learning independently. The package was developed using an iterative approach, incorporating feedback from subject-matter experts and students to refine its content and instructional design [29, 30]. The different elements, structured learning activities, and assessment tools, the learning package enhances the overall educational experience and prepares students for real-world automotive air-conditioning applications.

***Ethical considerations***

This study adhered to ethical principles to ensure the protection and welfare of all participants. Prior to data collection, informed consent was obtained from all students and faculty members involved in the study[31]. Participants were informed about the purpose of the study, the procedures involved, and their right to withdraw at any time without any consequence[32]. Confidentiality and anonymity were strictly maintained by assigning unique identification codes to each participant rather than using personal information. All collected data were securely stored and accessible only to authorized researchers to prevent unauthorized access[33]. Additionally, approval from the Institutional Research Ethics Committee was sought to ensure compliance with ethical research standards.

## RESULTS AND DISCUSSION

***Acceptability of the Learning Package***

The acceptability of a learning package is crucial for its successful implementation, as students are more likely to engage with materials that are well-structured, relevant, and aligned with their learning needs [34, 8]. If a learning package is perceived as ineffective or difficult to use, it can impede students' ability to grasp essential concepts, ultimately affecting their academic performance and skill acquisition [35]. Table 3 shows the results of the level of acceptability of the learning package.

**Table 3, Level of Acceptability of the Learning Package**

| Parts of the Learning Package/Question Items | Mean | Description |
|---|---|---|
| **Information Sheet** | | |
| 1. The Information sheet provides a clear learning Outcome | 3.56 | HA |
| 2. The Information sheet emphasized the conceptual knowledge about the topic | 3.46 | HA |
| 3. The Information sheet provides a guideline congruent to the Learning Outcome | 3.37 | HA |
| Overall Mean for Information Sheet Acceptability | 3.46 | HA |
| **Learning Outcomes** | | |
| 1. The AACSLP learning outcomes are aligned to AT-312 Syllabi and TR | 3.41 | HA |
| 2. The AACSLP covers all the learning outcomes of Automotive Air-Conditioning system. | 3.56 | HA |
| 3. The AACSLP is measurable and attainable | 3.67 | HA |
| Overall Mean for Learning Outcomes | 3.54 | HA |
| **Task Sheet** | | |
| 1. The Task sheets provides activities that is related to the learning outcome/s | 3.76 | HA |
| 2. The Task sheets instruction are simple to follow | 3.82 | HA |
| 3. The Task sheet contains a comprehensive planning strategy | 3.76 | HA |
| Overall Mean for Task Sheet | 3.78 | HA |
| **Performance Criteria** | | |
| 1. Criteria for checking student's performance are provided with scoring rubrics | 3.46 | HA |
| 2. Criteria in scoring rubric is measurable, and attainable. | 3.51 | HA |
| 3. Criteria for students' performance is adopted in the course Learning outcome of AT-312 Syllabi | 3.62 | HA |
| Overall Mean for Performance Criteria | 3.53 | HA |

Mean and SD were used to analyze the acceptability of the learning package. Data analysis results revealed that all four evaluated components—Information Sheet, Learning Outcomes, Task Sheet, and Performance Criteria—were rated as highly acceptable (HA). The Information Sheet had an overall mean score *(M=3.46)* indicates that it effectively provided clear learning outcomes and guidelines. The Learning Outcomes component *(M=3.54)*demonstrates strong alignment with the AT-312 syllabi and technical requirements. The Task Sheet achieved the highest acceptability rating *(M=3.78*), highlighting its effectiveness in providing structured activities and clear instructions. Lastly, the Performance Criteria *(M=3.53)* suggests that the rubric for student assessment was well-defined and aligned with course objectives.These findings indicate that the learning package is a well-structured and effective instructional tool that enhances students' learning experiences. The high acceptability ratings suggest that the learning package meets the instructional needs of both students and educators, reinforcing its usefulness in technical education. The structured design of the package, which integrates clear information sheets, measurable learning outcomes, detailed task sheets, and a well-defined performance rubric, contributes to its effectiveness. Research

supports that well-designed instructional materials enhance student engagement and learning outcomes, particularly in technical and vocational education [36],[27]. According to Clark and Mayer[26], instructional design that incorporates structured learning activities and formative assessments helps students retain and apply knowledge effectively. Additionally, studies indicate that competency-based learning tools improve student performance by bridging theoretical and practical knowledge [28, 37] These results highlight the significance of well-designed instructional materials in fostering engagement and improving competency acquisition in automotive air-conditioning systems. The positive reception of the learning package underscores its potential for broader implementation in automotive education programs to bridge the gap between theoretical knowledge and hands-on application.

***Academic Performance of the Students Before and After the Implementationof theLearning Package***

The pre-test and post-test results were analyzed using mean and standard deviation to measure students' academic performance before and after utilizing the learning package. The analysis indicated that students' post-test scores were significantly higher than their pre-test scores, demonstrating improved comprehension and practical application of automotive air-conditioning concepts. These findings align with previous studies that emphasize the role of instructional materials in enhancing learning outcomes, particularly in technical education [37]. The significant improvement in student performance supports the notion that well-designed learning tools facilitate cognitive and psychomotor skill development, leading to better mastery of technical subjects [27].These results highlight the importance of providing students with structured learning materials to support their academic growth and professional readiness. According to Clark and Mayer [26], learners retain information more effectively when instructional materials integrate theoretical knowledge with hands-on application. Furthermore, competency-based learning approaches have been shown to enhance student engagement and foster self-directed learning [36]. The substantial increase in students' post-test scores demonstrates that the learning package successfully bridged the gap between theoretical instruction and real-world application. This suggests that integrating such instructional materials into technical courses can contribute to producing highly skilled graduates prepared for industry demands [28]. Table 4 shows the results of pre- and post-test in Automotive Air-conditioning competencies.

**Table 4: Pre-Test and Post-Test Performance in Automotive Air Conditioning**

| Tests | Mean | SD |
|---|---|---|
| Pre-Test | 13.00 | 1.65 |
| Post-Test | 21.23 | 1.69 |

***Effect of Learning Package to the Academic Performance of the Students***

A paired samples t-test was conducted to determine whether the learning package significantly improved students' academic performance in automotive air-conditioning competencies. The results indicated a statistically significant difference between the pre-test *(M = 13.00, SD = 1.65)* and post-test *(M = 21.23, SD = 1.69)* scores, $t(39) = -24.15$, $p < .001$. The mean difference of *-8.23 (SD = 2.15)* suggests a notable improvement in students' comprehension and practical skills, leading to the rejection of the null hypothesis.The substantial increase in post-test scores can be attributed to the structured design of the learning package, which incorporates instructional elements that facilitate learning. Features such as clear information sheets, well-defined learning outcomes, interactive task sheets, and comprehensive performance criteria provided students with a scaffolded learning experience. According to Clark and Mayer [26], instructional materials that offer structured guidance, formative assessments, and hands-on applications significantly enhance student comprehension and retention. Similarly, Reigeluth[36] emphasized that competency-based learning tools improve both cognitive and psychomotor skills, which are crucial in technical education. The results reinforce the importance of integrating well-designed instructional materials to bridge the gap between theoretical knowledge and practical application, ensuring that students develop industry-relevant competencies [37, 28]. Table 5 presents the paired samples t-test results of data analysis.

**Table 5 Paired Samples T-Test Analysis of the Pre and Post-test Scores in Automotive Air Conditioning**

| | | Paired Differences | | | | | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | t-value | df | p-value | Decision |
| Pair 1 | Pre-test Post-Test | -8.23 | 2.15 | -24.15 | 39 | .000 | Null hypothesis is rejected |

## CONCLUSION

The findings of this study provide strong evidence that the innovative automotive air-conditioning system learning package is an effective instructional tool for enhancing students' academic performance. The high acceptability ratings of its key components—information sheet, learning outcomes, task sheet, and performance criteria—demonstrate that it meets the needs of both students and educators, making it a viable resource for instructional purposes. The results of the paired samples t-test analysis indicate a statistically significant improvement in students' post-test scores, confirming that the learning package effectively facilitated their comprehension and skills acquisition in automotive air-conditioning competencies. The structured and interactive design of the package, which includes guided learning materials and hands-on applications, contributed to this improvement by bridging theoretical concepts with practical execution. These findings suggest that the integration of well-designed instructional materials in technical education can significantly enhance students' learning experiences and better prepare them for industry demands.

## RECOMMENDATIONS

Future research may consider employing a more rigorous experimental design, such as quasi experimental to further validate the effectiveness of the learning package and minimize potential biases associated with the one-group pre-test and post-test design. Additionally, longitudinal studies could be conducted to assess the long-term retention and application of knowledge gained through the learning package. Future research may also incorporate a mixed-methods approach, integrating qualitative data to gain deeper insights into students' learning experiences and challenges. In terms of curriculum enhancement, it is recommended that educators consider incorporating structured learning packages into the automotive air-conditioning curriculum to reinforce competency-based learning. The integration of interactive digital resources and simulation-based learning may also be

explored to further enhance student engagement and practical skill development. Moreover, institutions are encouraged to provide continuous faculty training to ensure the effective implementation of instructional materials and alignment with industry standards, thereby improving overall student learning outcomes and employability prospects.

.

## REFERENCES


[1] A. Asniwaty, S. Sumarto, A. Abdullah and A. Setiawan, "aps in automotive laboratory facilities in vocational high schools with vocational technology education colleges," in *IOP Conference Series Materials Science and Engineering*, 2020.

[2] E. B. Nuevo, "Adequacy, Utilization of Laboratory Equipment," *International Journal for Multidisciplinary Research,* vol. 6, no. 3, pp. 1-32, May-June 2024.

[3] A. T. Cuartocruz, "Evaluating troubleshooting Skills of Electronics Technology Studnets for Industry Relevance," *Science International Lahore,* vol. 36, no. 6, pp. 641-647, 2024.

[4] N. Delos Reyes, "Preparednes sof TVL Program Implementation at a Public Secondary memorial School in Zamboanga Peninsula: FAcilties, Tools, and Teacher Qualifications," *Science International Lahore,* vol. 37, no. 1, pp. 63-69, 2024.

[5] B. Juhi and T. Kandra, "Experiential Learning Enhances Retention of Knowledge for Long Term and Helps in Easy Recalling for Futuristic Aspect," in *Proceedings of 10th International Conference on Digital Strategies for Organizational Success*, 2019.

[6] S. Namoco, "Determinants in the Use of Web 2.0 Tools in Teaching among the Philippine Public University Educators: A PLS-SEM Analysis of UTAUT," *Asia Pacific Journal of Educators and Education,* vol. 36, no. November 2, 2021, pp. 77-98, 2022.

[7] S. O. Namoco and R. Zaharudin, "Potential of Interactive Learning Objects (ILOs) as Non-Face-to-Face Learning Tool Among Trainee Teachers in the Philippines," *Malaysian Journal of Education,* vol. 46, no. 1, pp. 22-32, 2021.

[8] R. Sambaan and S. Namoco, "Assessment of Interactive Learning Objects for Carpentry among BTLED students in a state university in Cagayan de Oro City," *Science International Lahore,* vol. 34, no. 6, pp. 557-561, 2022.

[9] J. D. Daleon and S. O. Namoco,, "Determinants of Instrcutional Technology Use on Tec-Voc Educators in a State University in Northern Mindanao, Philippines," *Science International Lahore,* vol. 35, no. 2, pp. 131-136, 2023.

[10 E. Esquinas, and S. O. Namoco, "Utilization of TAM to Evaluate the Acceptability of Programmable Pedagogical Robot in Electro-Mechanical Course," *Science International Lahore,* vol. 35, no. 2, pp. 143-146, 2023.

[11 "The Importance of Automotive HVAC Skills for Mechanics," APEX Technical School, 16 November 2022. [Online]. Available: https://apexschool.com/toolbox/importance-of-auto-hvac-skills-for-mechanics/.

[12 "Automotive Air Conditioning," Motor Traders' Association of NSW, [Online]. Available: https://www.mtatraining.com.au/Courses/Air%20Conditioning/air-conditioning-courses.

[13 A. Czerwinska-Lubszczyk, M. Grebski and D. Jagoda-Sobalak, "Competencies of Graduates - An Industry expectations," *Management Systems in Production Engineering,* vol. 30, no. 2, pp. 172-178, 2022.

[14 P. Tulsi and M. Poonia, "Expectations of Industry from Technical Graduates: Implications for Curriculum and Instructional Processes," *Journal of Engineering Education Transformations,* February 2015.

[15 C. Edpalina, JG and S. O. Namoco, "A Tracer Study of Master in Technician Teacher Education: A Basis for Strategic Curriculum Alignment for Professional Success," *Science International Lahore,* vol. 35, no. 2, pp. 327-332, 2023.

[16 D. T. Campbell and J. C. Stanley, Experimetal and Quasi-Experimental Designs for Research, Houghton Mifflin Company, 1963.

[17 W. R. Shadish, T. D. Cook and D. T. Campbell, Experimental and Quasi-Experimental Designs for Generalized Causal Inference, 2nd edition ed., Cengage Learning, 2002.

[18 J. D. Cereswell and J. W. Creswell, Research design: qualitative, quantitative, and mixed methods approaches, 5th Edition ed., Los Angeles: SAGE Publications, 2018.

[19 J. R. Fraenkel, N. E. Wallen and H. H. Hyun, How to Design and Evaluate Research in Education, 10th edition ed., McGraw-Hill Education, 2019.

[20 M. Pergamit, *Aligning the Target Population, Study,* 2021.

[21 L. R. Gay, G. E. Mills and P. W. Airasian, Educational Research: Competencies for Analysis and Applications, 11th edition ed., Pearson education, 2016.

[22 J. W. Best and J. V. kahn, Research in Education, 10th Edition ed., Pearson Education, 2016.

[23 W. M. Trochim, J. P. Donnelly and Arora, Research Methods: The Essential Knowledge Base, 2nd Edition ed., Cengage Learning, 2016.

[24 M. R. Lynn, "Determination and quantification of content validity," *Nursing Research*, vol. 35, no. 6, pp. 382-386, 1986.

[25 A. Field, Discovering Statistics Using IBM SPSS Statistics, 5th Edition ed., SAGE Publications, 2018.

[26 R. C. Clark and R. E. Mayer, e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning, 4th edition ed., JOhn and Wiley Sons, 2016.

[27 M. D. Merrill, "First principles of instruction," *Educational technology research and development*, vol. 50, pp. 43-59, 2002.

[28 K. Sawyer, The Cambridge Handbook of the Learning Sciences, 3rd edition ed., Cambridge University Press, 2022.

[29 S. O. Namoco and R. Zaharudin, "Pedagogical Beliefs and Learning Assessment in Science: Teacher's Experiences Anchored on Theory of Reasoned Action," *Journal of Turkish Science Education*, vol. 18, no. 2, pp. 304-319, 2021.

[30 R. Hare, S. Ferguson and Y. Tang, "Enhancing student experience and learning with iterative design in an intelligent educational game," *British Journal of educational Technology*, vol. 00, pp. 1-18, 2024.

[31 E. Mollard, H. Hatton-Bowers and J. Tippens, "Finding Strength in Vulnerability: Ethical Approaches when Conducting Research with Vulnerable Populations," *Journal of Midwifery women's Health*, vol. 65, no. 6, pp. 802-807, 2020.

[32 "APA Ethics Code Addresses When Obtaining Informed Consent From Research Participants Is Necessary," American Psychology Association, 2014. [Online]. Available: https://www.apa.org/news/press/releases/2014/06/informed-consent.

[33 K. Kaiser, "Privacy, Anonymity and Confidentiality," Research Methods Toolkit, 2009. [Online]. Available: https://researchmethodstoolkit.com/ethics/privacy-anonymity-and-confidentiality/.

[34 A. E. Vigor, S. O. Namoco and M. Isa, "Assessment of the Interactive Spatial Intelligence Module for First Year Architecture Students," *Science International LAhore*, vol. 35, no. 1, pp. 93-100, 2023.

[35 R. E. Mayer, "Multimedia Learning," in *The Psychology of Learning and Motivation*, USA, Elsevier, 2002, pp. 85-139.

[36 C. Reigeluth, Instructional-design theories and models: A new paradigm of instructional theory, vol. 2, C. M. Reigeluth, Ed., Lawrence Erlbaum Associates, 1999.

[37 J. Biggs, and C. Tang, Teaching for Quality Learning at University, Maidenhead, UK: Open University Press, 2011.

[38 A. Valera, S. O. Namoco and A. :. San Diego, "Effectiveness of 3D Solid Model on Improving Spatial Visualization Ability for Technical Drafting Students," *Science International Lahore*, vol. 15, no. 4, pp. 159-164, 2021.

[39 L. Cohen, L. Manion and K. Morrison, Research Methods in Education, 8th edition ed., Routledge, 2017.