Development and Evaluation of Transparent House Model as Instructional Tool for Industrial Arts Students of Quirino State University

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***Abstract*: This study developed and evaluated a Transparent Plumbing System House Model as an instructional tool for teaching plumbing concepts in Industrial Arts education. The study was guided by the ADDIE instructional design framework, incorporating the stages of Analysis, Design, Development, Implementation, and Evaluation. The model was designed to address students' difficulties in visualizing residential plumbing systems due to the concealed nature of pipes and components in actual structures. A developmental research approach was employed, involving 15 plumbing professionals and 15 Industrial Arts students who evaluated the model based on design and structure, functionality, sustainability, and instructional potential. Grounded in Constructivist and Experiential Learning theories, the model provided learners with hands-on and visual learning experiences. Findings aimed to determine the model's level of acceptability and identify any significant differences between expert and student evaluations. The study contributes to enhancing technical-vocational instruction through innovative, practical, and context-based learning resources.**

***Keywords*: Transparent Plumbing System House Model, Industrial Arts Education, ADDIE Framework, Instructional Material Development, Experiential Learning, Technical-Vocational Education, Plumbing Instruction.**

1. Introduction

A. Background of the Study

Students often struggle to understand plumbing systems because pipes and components are hidden inside walls and floors. Traditional learning methods and field visits make it difficult for learners to visualize how the entire plumbing system functions in real residential structures. To address this gap, the study developed a transparent house model that allows students to clearly observe plumbing components and their connections, improving visualization, understanding, and instructional effectiveness in teaching plumbing concepts in Industrial Arts education.

There has been a significant global increase in recognizing the need to modernize Technical and Vocational Education (TVE) to better equip students with the competencies required by the evolving workforce. International organizations such as UNESCO (2020) advocate for the integration of simulations and hands-on learning tools in Technical and Vocational Education and Training (TVET) curricula to enhance the acquisition of practical skills in fields such as plumbing. These tools are particularly important in skill-intensive disciplines, as they help learners develop both conceptual understanding and hands-on competence. Supporting this, international studies such as Smith et al. (2022) emphasize that inductive teaching approaches, including Problem-Based Learning, improve student learning in engineering and technology fields; however, they also stress that such innovations must be grounded in empirical evidence and contextual relevance to ensure their effectiveness.

At the national level, the Philippines reflects this global direction through its educational policies and research agendas. The Commission on Higher Education (CHED), through Memorandum Order No. 79, Series of 2017, mandates the use of appropriate instructional tools and materials to enhance the quality of higher education. Similarly, the Technical Education and Skills Development Authority (TESDA), through Circular No. 062, Series of 2020, promotes competency-based training aligned with industry standards. These initiatives are further supported by broader frameworks such as Sustainable Development Goal 4 (Quality Education), the National Research Agenda for Teacher Education (NRATE), and the College of Teacher Education (CTEd) Research Agenda, all of which emphasize innovation, contextualization, and the development of industry-relevant skills.

Despite these directives, many institutions in the Philippines, particularly at the local level, including colleges, universities, and TVL programs, still rely heavily on traditional instructional approaches such as lectures and printed materials in teaching plumbing. These methods often fall short in represent the three-dimensional, procedural, and dynamic nature of plumbing systems. As a result, students encounter difficulties in visualizing water flow and understanding the functional relationships among components when concepts are presented only through two-dimensional illustrations. This gap between theory and practice limits their confidence and ability to perform tasks effectively.

Consequently, Industrial Arts students specializing in plumbing face challenges in developing essential skills such as spatial reasoning, systems thinking, mechanical analysis, and installation planning. They may also struggle to fully understand the interaction of plumbing components, including valves, traps, and fittings, due to the abstract nature of current instructional materials. These limitations affect not only their academic performance but also their readiness for employment in the field.

Anchored on Kolb's (2015) Experiential Learning Theory, this study underscores the importance of direct engagement and hands-on experience in enhancing students' conceptual understanding and technical proficiency. In line with the priorities of TESDA training regulations and the research agenda of CTEd and NRATE, this study aimed to develop a transparent plumbing system house model as an instructional tool. The model is designed to allow learners to clearly observe water flow, understand system operations, and visualize the processes involved in installation, repair, and maintenance. Through this, the study seeks to support the development of key competencies such as assembling, installing, repairing, and maintaining plumbing systems, which are essential for industry readiness.

Finally, recognizing that innovation must be both functional and sustainable, the study emphasizes the need to evaluate the developed instructional model across multiple dimensions. Specifically, the model was assessed in terms of design and structure, functionality, sustainability, and instructional potential. This evaluation ensures that the developed tool is not only innovative but also practical, adaptable, and effective in enhancing teaching and learning. Ultimately, the study contributes to the advancement of technical-vocational education in the Philippines by addressing gaps in instructional practices through localized and evidence-based innovation.

B. Statement of the Problem

This study aimed to develop and evaluate a transparent plumbing system house model as an instructional tool in the teaching of plumbing under the Industrial Arts curriculum at the college level. The study focused on assessing the acceptability of the model among two respondent groups, plumbing professionals and students, particularly in terms of its design, functionality, sustainability, and instructional potential. It also examined how users perceive its value as a learning support tool in the classroom setting.

Specifically, the study sought to answer the following research questions:

1. What transparent house model could be developed based on the ADDIE instructional design framework (Analysis, Design, Development, Implementation, and Evaluation)?
2. What is the level of acceptability of the developed transparent plumbing system house model as assessed by experts and students in terms of design and structure, functionality, sustainability, and instructional potential?
3. Is there a significant difference between the evaluation of the experts and industrial arts students?

C. Objectives of the Study

This study aimed to develop and evaluate a transparent plumbing system house model as an instructional tool for Industrial Arts students, specifically those specializing in plumbing. Guided by the ADDIE instructional design framework, the study sought to achieve the following specific objectives:

1. To develop a transparent plumbing system house model based on the ADDIE instructional design framework, following the stages of Analysis, Design, Development, Implementation, and Evaluation
2. To evaluate the level of acceptability of the developed transparent plumbing system house model in terms of design and structure, functionality, sustainability, and instructional potential
3. To determine if significant difference exists between the evaluation of the experts and industrial arts students

D. Null Hypothesis of the Study

This study tested the hypothesis that there is no significant difference between the evaluation of the experts and industrial arts students.

E. Significance of the study

This study will be beneficial to the following stakeholders:

Students. The students will find the model is an advanced educational material that allows them to learn about piping systems through observing how water flows through different pipes and fittings with their own eyes. This experiential method of learning provides for a greater level of conceptual knowledge and skill development than traditional methods.

Industrial Arts Teachers. The transparent plumbing system house model serves as a supplemental instructional tool that aids in providing a hands-on, visual representation of plumbing principles, plumbing system layouts and how water flows through those systems. It will enhance the ability to deliver competency-based training and provide for better student engagement and retention.

TESDA Trainers. The model can be incorporated into any Technical-Vocational Education and Training (TVET) program and support both TESDA trainers and Industrial Arts teachers in developing more effective instructional approaches.

Curriculum Developers and Instructional Designers. The results of this research study are examples of the incorporation of student friendly, tangible instructional materials within the Industrial Arts curriculum and could possibly encourage the use of such models in other technical-vocational subject areas.

School Administrators and Officials. The results of this study can provide direction to school administrators and officials in making investment decisions for cost-effective, functional and sustainable instructional materials to help improve technical-vocational education outcomes.

Future Researchers. This research study has contributed to the body of knowledge on instructional material development and can serve as a reference for future researchers who develop research projects involving instructional materials in other disciplines or technical areas.

F. Scope and Delimitations of the Study

The purpose of this research project was to develop and evaluate a model of a transparent plumbing system house that can be used to improve student understanding of plumbing concepts under the Industrial Arts curriculum, particularly in the field of Civil Technology. In addition to the overall goal of assisting students in developing their competency in recognizing plumbing materials and installing waterlines and waste lines as per TESDA Training Regulations for Plumbing and applicable learning competencies under the Technical-Vocational-Livelihood (TVL) strand, this study also sought to identify what competencies students may require to effectively install and recognize plumbing material and to further develop educational programs to meet those needs. Specifically, the study focused on the competencies of identifying plumbing materials and installing waterline and wasteline systems.

To achieve this, the researchers planned to conduct this study in the second semester of Academic Year 2025–2026 at two separate institutional locations: Quirino State University (QSU)-Maddela Campus and Nueva Vizcaya State University (NVSU)-Bambang Campus, while receiving input regarding technical consultation from Southern Isabela College of Arts and Trades (SICAT). The study included two respondent groups namely, Group 1: Fifteen (15) plumbing professionals: Eight (8) QSU faculty members and seven (7) NVSU-Bambang Campus trainers who are either Industrial Arts/Civil Technology instructors, TESDA accredited, or have academic specialization in plumbing. The experts assessed the prototype in terms of technical specifications, design validity, and instructional suitability in order to validate the model during the development stage. Group 2 include 15 students enrolled in the Civil Technology program at QSU-Maddela Campus in the first semester of SY 2025–2026, who assessed the acceptability of the prototype as the intended end users. The evaluation focused on the criteria of design and structure, functionality, sustainability, and instructional potential, with a total of 30 respondents.

In terms of the development process of the instructional tool, the study followed the ADDIE instructional design framework which defines five stages: Analysis, Design, Development, Implementation, and Evaluation. The study utilized a developmental approach based on the ADDIE model as described by Molenda (2003), emphasizing iterative development of the prototype based on expert feedback and contextual learning needs of students.

In addition to this, the evaluation criteria and instruments utilized in this study were adapted from validated tools referenced by Padua and Regacho (2017) and consistent with guidelines provided by the Department of Education (DepEd) and TESDA, providing content validity and relevance to technical-vocational learning outcomes.

The study is limited to the plumbing system of the instructional model only and excluded any electrical or mechanical components of the same. In addition to this, the study did not intend to compare the developed model with other instructional models available, but rather intends to determine the perceived acceptability of the prototype by respondents based on their training, instructional experience, and academic exposure to plumbing. Furthermore, the model was scaled to fit the size of the prototype for classroom use, which may limit the full representation of actual residential plumbing systems.

G. Theoretical/ Conceptual Framework

This study was guided by two fundamental learning theories: Constructivist Learning Theory by Jean Piaget and Lev Vygotsky and Experiential Learning Theory by David Kolb; along with a widely accepted framework for developmental research that would help create an instructional model.

The Constructivist Learning Theory posits that learners build knowledge from their own experiences and interactions with their environment. As such, this theory supports the integration of hands-on, interactive models of technical systems into industrial arts instruction to allow learners to see and physically manipulate these systems. According to Piaget, it is through learner-driven discovery that individuals develop cognitively, and according to Vygotsky, it is through social interaction and scaffolding by more knowledgeable peers or instructors. Thus, the transparent house model allows learners to be actively engaged with and understand the context of plumbing mechanics through visualization and manipulation of the systems involved, and abstract and spatial concepts cannot be effectively conveyed through static diagrams and lectures alone.

Kolb's Experiential Learning Theory (1984) also supports this view by defining learning as a continuous process of experiencing, observing, conceptualizing, and experimenting. The transparent house model will provide learners with a direct and immersive experience to visually observe the flow of water, visually observe how the various components of the plumbing system interact with one another, and visually observe how plumbing fixtures operate. The above described model will also support the opportunity for learners to reflect upon and analyze what they have learned to make connections between theoretical knowledge and practical skills — which is crucial in developing the necessary competency to identify types of plumbing material, and to install waterline and wasteline systems.

This study utilized the ADDIE framework, a systematic instructional design model consisting of Analysis, Design, Development, Implementation, and Evaluation, which is widely used in developing educational tools and learning systems. The ADDIE model is supported by recent literature emphasizing its effectiveness in guiding the structured development and evaluation of instructional materials and technologies, particularly in technical and vocational education (Branch, 2009; Peterson, 2020; Aldoobie, 2015).

1. Analysis. This evaluation process determined the instructional needs and identified learning gaps that existed in the understanding of residential plumbing systems. This evaluation also helped identify the required competencies of students and reviewed all existing instructional resources and consulted with plumbing professionals and Industrial Arts Instructors to determine both the technical and pedagogical requirements for the transparent house model.
2. Design. During this planning process the instructional layout and structure of the transparent house model was developed. Technical specifications, detailed plans for the layout of components, and a plan for the overall instructional layout were completed. Plans were made for the selection of materials used for the model, the clarity of visual elements, the arrangement of components within the model, and how the overall model would be aligned to the intended learning objectives for the plumbing curriculum.
3. Development. During this implementation phase, the transparent house model was constructed as per the finalization of the plans from the previous planning phase. The model was refined and technically modified to meet the requirements of being functional, durable and suitable for instructional use. Subject Matter Experts evaluated the prototype for its technical accuracy regarding the subject matter of plumbing, operationally performed as expected, user friendly, and relevant to the instructional goals for teaching plumbing. Based upon their evaluations, the prototype was revised accordingly.
4. Implementation. During this phase, the transparent house model was presented and used in a real instructional setting. Both students and experts saw the model in action. They could observe and interact with the system to understand how water moves through the plumbing parts. This phase made sure the model was tested in a realistic learning environment before evaluation.
5. Evaluation. During this stage, both experts and students assessed the newly designed model of a transparent house by utilizing an assessment tool that had been proven as reliable by researchers. Experts and students provided feedback about the design and structural integrity of the home, its operational characteristics (functional), the sustainable aspects of the home, and educational value for students. After collecting data, the researcher used various statistics to evaluate whether or not the house model was satisfactory and to identify whether any statistically significant differences existed in their assessments.

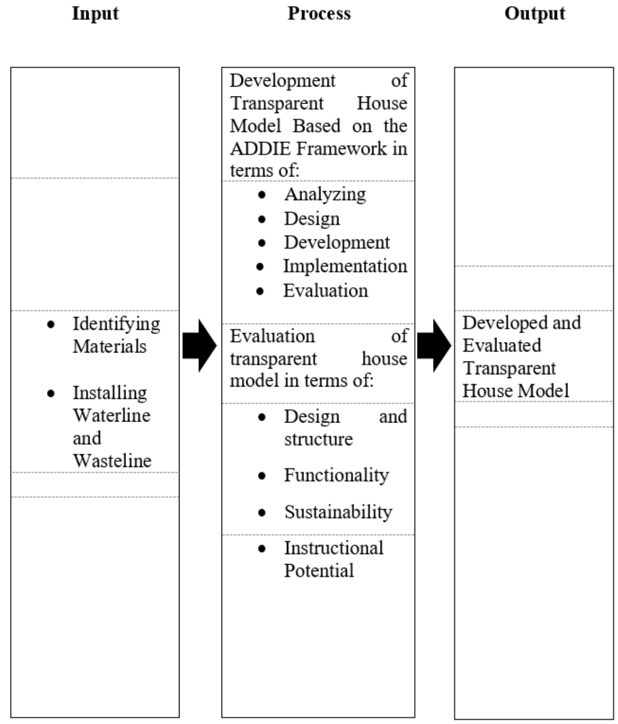

Fig. 1. Structure the research process

To structure the research process, the study is further framed using the Input–Process–Output (IPO) model.

This input items include identified key competency areas in plumbing education Identifying Materials, and Installing Waterlines and Wastelines. The competency areas are used to create the house model conceptualization and the actual model of the transparent plumbing system. They represent the skill and knowledge that students should develop through their experiences in industrial arts courses they provide a direct link between the curriculum, the student, and the performance expectations of the students.

Process is the next frame and it included an overview of the process (analyzing, designing, and developing) and design components of the model (design and structure, functionality, sustainability, and instructional potential). Data collected during this phase was analyzed statistically with evaluation tools.

Output is the transparent plumbing system house model created and tested for use in teaching plumbing in industrial arts courses. In addition to the model itself, results of acceptability and prior plumbing knowledge's impact on evaluating the model as well as recommendations for instructional use and potential revisions for future refinements are reported. This research paradigm allowed the researcher to create an effective instructional tool that is functionally operational, pedagogically viable, and appropriately contextualized for instructional settings.

H. Conceptual-Operational Definition of Terms

Acceptability. Acceptability refers to the extent to which the end-users perceive an educational tool as suitable, relevant, and effective for its intended purpose (Sekaran & Bougie, 2016). In this study, acceptability was assessed through the responses of the participants on four aspects of the educational tool's design and function, namely: design and structure, functionality, sustainability, and instructional potential, using a standardized Likert-scale survey.

Analysis. is the systematic assessment of a learner's needs, instructional barriers, and context-based factors before developing educational content (Branch, 2009). In this study, analyzing was carried out through identifying student difficulties with plumbing system knowledge, analyzing curriculum specifications, and specifying which competencies are to be addressed by the transparent house model.

Design. This is the process for conceptualizing and organizing the intended instructional content of the proposed instructional materials; as well as the features of each component, layout, and learning experience (Molenda, 2015). In this study, design included developing a preliminary organization of the model of the transparent house, choosing an acceptable material, establishing an appropriate configuration of the waterline and wastewater systems in order to provide a visual and functional representation of the major plumbing concepts of the house.

Development. Where the instructional content will be created, built, and refined in accordance with the details developed during the Design Phase (Reiser & Dempsey, 2018). In this study, the development stage involved assembling the transparent Plumbing House Model, installing the waterline and wasteline components, integrating transparent materials into the plumbing house model for increased visibility and demonstrating and testing the plumbing house model's structural integrity and functionality.

Implementation. This refers to the phase where the developed instructional material is introduced and utilized in an actual learning environment to determine its usability and effectiveness in facilitating instruction (Molenda, 2015). In this study, implementation involved presenting the transparent plumbing system house model to both experts and students in a classroom setting, allowing them to observe, interact with, and experience how the model demonstrates the flow of water and the function of plumbing components during actual instruction.

Evaluation. This is the process of systematically assessing the effectiveness, quality, and acceptability of an instructional material based on predetermined criteria and user feedback (Reiser & Dempsey, 2018). In this study, evaluation was carried out through collecting responses from experts and students using a structured Likert-scale questionnaire, focusing on design and structure, functionality, sustainability, and instructional potential, and analyzing the data using statistical tools such as weighted mean and independent t-test to determine the level of acceptability and differences in assessment.

Design and Structure. Design and structure relates to the extent to which an instructional model is physically arranged and constructed to display real-world systems in an accurate and clear manner (Gagné et al., 2017). In this study, the operational aspect of design and structure was assessed by the clarity of the model's layout, the realism of the arrangement of the various plumbing components within the model, the overall stability of the model's construction, and the ease of observing the path of the waterline and the wasteline in the transparent house model.

Functionality. Functionality relates to the extent to which an instructional material effectively achieves its intended goal. Functionality was operationally assessed through the accuracy of the representation of plumbing concepts, the smoothness of the water flow demonstration, and the ability of the model to communicate clearly the installation and drainage functions associated with plumbing. A similar operationalization of functionality was used in the study by Gutierrez et al. (2021). Functionality was operationally assessed through the accuracy of the representation of plumbing concepts, the smoothness of the water flow demonstration, and the ability of the model to communicate clearly the installation and drainage functions associated with plumbing.

Instructional Potential. Instructional potential relates to the ability of an educational tool to enhance the understanding and knowledge acquisition of learners (Biggs, 1999). Instructional potential was operationally assessed by the degree to which the model facilitates students' learning and understanding of plumbing skills through hands-on/visual means, particularly with respect to identifying materials and assembling waterline and wasteline systems.

Sustainability. Sustainability in educational materials relates to the ability of the materials to endure repeated use and continue to provide value over time (Sterling, 2019). Sustainability was operationally defined as the durability of the transparent plumbing model, the cost-effectiveness of the model, the minimal maintenance required to maintain the model, and the potential for extended use by multiple classes or academic years.

Waterline and Wasteline. Waterline and wasteline relate to the assembly and connection of piping systems to facilitate the distribution of water and the removal of wastewater within residential or commercial buildings. The model illustrates these systems in a transparent fashion to allow students to observe the flow of water, the location of the pipes and the connections between them, consistent with the training requirements for TESDA in plumbing NC1.2016).

2. Review of Related Literatures and Studies

Local studies that seek to improve the effectiveness of teaching in Industrial Arts with a focus on plumbing education, emphasize the need for the creation of new, interactive and contextualized educational resources. Local studies examine a variety of methods (digital simulations, modular learning, etc.)

that are designed to close the gap between theoretical training and practical application. This list provides a reference point for both the direction and the instructional intent of this study on the development and innovation of a resource. transparent plumbing system house model.

Plumbing Competencies

Studies have shown that developing technical abilities through plumbing education are important with regard to identifying plumbing supplies and assembling water and waste management systems. The Technical Education and Skills Development Authority (TESDA) Training Regulation for Plumbing NCII states that TESDA will examine whether or not graduates can identify plumbing tools and plumbing materials and assemble water supply and drainage systems as per the current standard practices of the trade. Similarly, Mariano and Dizon found that students of Technical Livelihood Education lacked sufficient hands on practice in laying pipe and interpreting blueprints because of their limited exposure to practical experiences. Additionally, Navarro (2022) discovered that although trainees were able to understand the basics of the trade, they were unable to use those skills in actual installations and/or in designing layouts.

Additionally, Delos Santos and Aquino (2021) noted that learners often lack a clear understanding of piping systems. This gap impacts their ability to correctly install and visualize water and waste connections. These findings underline the need for teaching tools that offer visual and practical learning experiences. As pointed out by Swisscontact (2024), modern plumbing education should use practical and technology-based teaching materials to enhance both understanding and technical skills. Collectively, these studies emphasize the need for instructional models that directly support the skills of identifying plumbing materials and installing water and waste systems.

Mariano and Dizon (2023) evaluated the need for plumbing-related skills in senior high school students who were enrolled in Technical Livelihood Education (TLE) in Region IV-A. The results indicated that these students had relatively low skill levels when it came to installing pipes and interpreting blueprints and had limited opportunities to be exposed to plumbing applications in the field. Based upon their findings, the researchers recommended that plumbing educational programs include practical aspects of the trade through the use of hands-on models and/or simulation-based technology to reduce the gap between theory and practice.

Navarro (2022) assessed the technical competency of plumbing National Certificate Level II (NCII) trainees at a TESDA accredited training center located in Cebu using a performance-based assessment strategy. While the results indicated that the trainees understood basic plumbing terminology and safety procedures, they were challenged when trying to diagnose problems or develop piping system layouts. The study highlighted the value of instructional scaffolding techniques including visual aids and transparent models of piping systems to increase the rate of retaining technical competency.

Similarly, Delos Santos and Aquino (2021) studied the effectiveness of a modular plumbing training program that was implemented in response to the COVID-19 pandemic in Nueva Ecija. According to their findings, the theoretical comprehension of the trainees remained consistent throughout the training; however, they did not have an adequate spatial understanding of piping systems. To address this issue, the researchers recommended incorporating transparent or augmented reality (AR)-based models of piping systems into future training programs to improve the trainees' spatial awareness and ability to comprehend how water flows through systems.

Swisscontact (2024) organized the 6th Educational-Practical Conference in Ukraine where Swisscontact served as the facilitator of collaboration between educators and professionals from the trades to modernize the education of plumbers. Their focus on the development of instructional materials and practical modules to support the modernization of plumbing education is similar to my goal of modernizing the technical teaching methods used in Industrial Arts.

Swisscontact – EdUP Project (2020–2027). As part of its EdUP project, Swisscontact has enhanced vocational education by providing up-to-date instructional materials for plumbing training programs. These materials focused on practical applications of plumbing concepts and included technological components to align with the goal of developing a functional transparent model of plumbing for use in the classroom.

A. Development of Instructional Material in Plumbing

Yang et al. (2020) presented the XR-Ed Framework, and its focus on the primary design elements for extended reality (XR) systems; i.e., physical accessibility and cognitive interaction. The XR-Ed Framework is also based upon learner-centered instructional design reinforcing the purpose of this research to develop a model for teaching plumbing that is accessible and understandable to students.

Ghobrial et al. (2025) investigated the development of augmented reality (AR) user manuals for machining equipment. The findings from the study highlight the design principles that will enhance clarity and user interaction in the technical training environment. The principles identified by Ghobrial et al. (2025) are consistent with the design criteria for developing transparent and demonstrative materials (such as the plumbing system), that will be used in the teaching of Industrial Arts.

Longo et al. (2022) introduced Sophos-MS, a human-centered AR solution that integrates with intelligent tutoring systems for the use in Industry 4.0 settings. The system provides real-time operational instructions, which illustrates how instructional systems may provide skill-based learning opportunities similar to the way the plumbing model is intended to provide students with real-time, step-by-step instructions for understanding the structure and function of water systems.

Yambao et al. (2022) developed an AR application to aid the made-to-order furniture manufacturing industry in Pampanga.

The application provided interactive, real-time visualizations to improve user engagement and learning illustrating the potential for digital simulations and models to be utilized in vocational and Industrial Arts education, which mirrors the objective of this study to provide a transparent plumbing model for instructional purposes.

Gong et al. (2025) developed CalliSense, an interactive educational tool to help illustrate brush movement in Chinese calligraphy. By recording real time writing motions, the system allows learners to develop a greater understanding of more complex techniques demonstrating another approach for providing visual-based instruction, similar to the method of making the invisible technical processes of the plumbing model visible to promote better comprehension by Industrial Arts students.

Motejlek and Alpay (2021) developed a comprehensive taxonomy for integrating virtual and augmented reality (VR/AR) tools into education. Motejlek and Alpay's (2021) taxonomy helps ensure that content delivery is aligned with technology and instructional tools are meaningful and relevant to the specific field of study similar to the plumbing system model's purpose to connect technical knowledge to practical instructional delivery within Industrial Arts.

Penuela et al. (2021) demonstrated mobile-based instructional materials for industrial technology education, emphasizing intuitive interfaces and content clarity. The authors' focus on creating student-centered and interactive instructional tools supports the model's objectives to make it visually informative and easy to understand for Industrial Arts students.

Benabdallah et al. (2021) presented innovative digital fabrication strategies used during remote education due to the COVID-19 pandemic. Benabdallah et al. (2021) illustrated that hands-on technical learning could continue to occur even while students were remote and created instructional alternatives to replace some of the traditional hands-on experience, which is one of the objectives of the plumbing model.

B. Evaluation of Instructional Material in Plumbing

The authors Mirand et al. (2020), created a 3D Engine Assembly Simulation Learning Module for Senior High School Students to assist in addressing equipment shortages. The 3D Engine Assembly Simulation Learning Module was evaluated against ISO 25010 Quality Standards and received a "Moderate Acceptable" rating. The authors conclude that 3D Technologies have the capability to be used in practical and laboratory-based subjects and as a result should be incorporated into plumbing education.

The study of Tan et al. (2021) measured the extent to which the instructional objectives were met, the instructional methods, and the appropriateness of instructional materials utilized in the TLE programs. The results indicated that there were insufficient instructional materials, specifically in Industrial Arts, and this limited the ability of students to learn industrial arts in a manner that is based on skill. As a result, there is a need for creative instructional materials, such as the transparent plumbing system model developed in this study.

Arellano and Lumogdang (2025) examined the use of technology in science-based instruction in Secondary Schools in Sarangani, Davao Occidental. The study concluded that the use of technology in science-based instruction is at a moderate level of implementation, indicating that although technology-based resources exist in the classroom, the technology is underutilized in technical subjects. Therefore, the findings of Arellano and Lumogdang support the need for developing practical, technology-based instructional tools in Industrial Arts education that align with the purpose of developing a transparent plumbing system model.

Grepon et al. (2021) developed and implemented an e-School Management Information System (e-SMIS) at a Community College in Northern Mindanao. The goal of this project was to improve the efficiency of community college administrators through digitizing administrative processes. Although this project had an administrative orientation, there is a clear example of how digitally enhanced tools can be used throughout education. Thus, the purpose of the current study fits within the scope of using technology to develop instructional tools which will increase student participation and improve function in vocational/technical education.

Magallanes et al. (2024) conducted a study on the perceived importance of ICT proficiency of Physical Education Teachers in Pampanga. Magallanes et al. (2024) emphasized the urgent need for teachers in all disciplines to implement or utilize ICT-based instructional tools to enhance instruction. Although this research focused on physical education, the results emphasize the need for teachers in all areas of study (including industrial arts) to have access to innovative tools (i.e., visual and interactive models) to assist them in providing instruction; therefore, supporting the design of the transparent plumbing system model.

Mendiola and Estonanto (2021) explored the use of teacher-made instructional materials in mathematics classrooms in Sorsogon. Although Mendiola and Estonanto (2021) studied a different subject area than industrial arts, they demonstrated many similar challenges in creating and implementing instructional material effectively. Therefore, the results demonstrate a general necessity for educators to have instructional materials that are well-developed and support the purposes of the current study to provide a specialized tool for industrial arts instruction.

Calanog (2021) sought to strengthen technical skills of TLE secondary teachers in Batangas. The study found that teachers often experience difficulty innovating due to resource limitations and lack of instructional materials. Calanog emphasized that professional development needs to occur simultaneously with access to effective instructional tools — supporting the significance of projects like the transparent plumbing model to support teaching practices in technical subjects.

Dela Cruz (2021) called for the creation of instructional materials that effectively integrate both the content and technology in teaching. This supports the development of a transparent plumbing system model that combines practical content and technology in Industrial Arts instruction.

Halili (2019) worked on Education 4.0 which illustrated a trend toward more innovative, technology-based pedagogies in teaching. Halili supported the need for visual, interactive, and simulation-based tools to satisfy the demands of modern learners. Although not specific to Industrial Arts, it indicates that tools such as a transparent plumbing system could greatly enhance the way technical subjects are taught in today's educational climate.

Guerrero et al. (2023), integrated the 4D Frame Mechatronics Kit in Primary STEM Education to encourage experiential learning. The kit enabled students to physically manipulate technical systems, and is very close to what this study is researching with regards to providing hands-on instruction in Industrial Arts through an interactive plumbing house model.

C. *Synthesis*

Following local and international research, it was found that there is a general consensus among the studies that instructional materials play a major role in facilitating technical education through innovation. Specifically, the research conducted by Guerrero-Osuna et al. (2023) and Gong et al. (2025) stated that the utilization of interactive and visual instructional aids assists students in understanding complex technical concepts more easily and effectively than non-interactive and non-visual aids. This information supports the goal of developing a transparent plumbing system house model to make the often difficult-to-understand processes of plumbing systems visible to students.

Studies conducted by Longo et al. (2022) and Ghobrial et al. (2025) further contributed to understanding how instructional materials should be developed, particularly in addressing the needs of the end-users. The results of these research projects have demonstrated how using an individual as a guide or focus when designing the instructional material (e.g. through giving immediate instruction) will increase the ability of the learner to gain knowledge. The results of the above research helped shape the development of a new model that was both educational and had the potential to be simple, fun and practical to use. Since the cited research used technology based instructional models it laid the groundwork for the creation of a non-technology model which would offer many of the same advantages in a more practical form

Local studies conducted by Tan (2021), Arellano and Lumogdang (2025), and Villanueva (2022) identified issues related to Industrial Arts instructional methods, including the use of outdated materials and low levels of student engagement. These issues directly relate to the objective of developing an innovative and interactive teaching tool for Industrial Arts in the Philippines, thereby reinforcing the relevance of the research.

The reviewed research clearly indicates the necessity for instructional resources which are innovative, practical and learner focused for developing technical skills. As a result of this demonstrated need, the purpose of this research is to develop an open piping systems model as a resourceful and novel teaching tool to assist students to learn about related plumbing concepts in Industrial Arts.

3. Research Methodology

This chapter outlines the methodology utilized in the development and innovation of a transparent plumbing system house model for use as a formation model in Industrial Arts. The research design, development processes, data collection methods, and method of analysis in the study are articulated. The methodological framework is based on the research goals and the questions specified in the previous chapters, which in turn ensures a structured and consistent account of the accomplishment of the aims of the study.

A. *Research Design*

This is a quantitative and developmental study using the ADDIE model as described by Molenda (2003). This type of study is best suited for the systematic development and evaluation of an instructional technology or tool, which requires a formalized approach to creating, evaluating and revising the educational tool through a structured process involving the collection of empirical evidence through testing; the input of experts; and feedback from users.

The author used the ADDIE framework in order to produce the most effective instructional model—a model of a house with a transparent plumbing system—for improving the teaching and learning of plumbing-related concepts in Industrial Arts. This method has been extensively used to develop new instructional models and tools in educational settings. The developed output was rated by experts and students.

B. *Research Environment*

The study was conducted at Quirino State University–Maddela Campus, located in Maddela, Quirino. Quirino State University offers many programs designed to meet the goals of technical-vocational education. Included among these are the courses under the Bachelor of Technology and Livelihood Education (BTLED) with a major in Industrial Arts, including civil technology, one of the main components of which is the study of the basics of plumbing. The inclusion of plumbing in the BTLED curriculum demonstrates the university's intent to provide students with practical experience they can apply in their future careers in the technical and vocational fields.

As such, Quirino State University presents a very suitable environment for conducting a developmental study, especially for developing and evaluating instructional innovations. The university has fully equipped laboratories, workshops, and training areas for hands-on learning, all of which make it an appropriate location for developing and evaluating a transparent plumbing system house model as an instructional aid.

Conducting this study in this manner ensured that the developmental process took place within a realistic classroom/learning setting, provided the opportunity for collaborative relationships to develop between the developers of the instructional innovation, the instructors who taught the classes using the innovation, and the students who learned from the innovation, and allowed for the iterative refinement of the instructional innovation as well as the overall developmental process, as defined by the principles of the ADDIE framework, ensuring that the instructional innovation developed was relevant and applicable in other similar educational settings.

C. Respondents of the Study

The two categories of respondents for this study were plumbing experts and student end-users. Plumbing experts consisted of faculty members teaching technology and vocational courses, and faculty members teaching technology courses. Of these 15 certified plumbing instructors, eight were from Quirino State University (QSU), while seven were from the Nueva Vizcaya State Institute of Technology. Together, they reviewed the prototype of the transparent plumbing system house model regarding its technical features, design criteria, and educational features to assist in answering the first two research questions of this study.

Student respondents represented the intended users of the instructional model. They were enrolled in the civil technology program and assessed the model's functionality, structural integrity, sustainability, and instructional value as an educational tool. It was beneficial to consider students’ current level of knowledge about plumbing to identify if there were any differences between the evaluations of the model from each group.

Table 1

Respondent Group	Frequency	Percentage
Experts (Faculty/Trainers)	15	50%
Students (BTLED – IA)	15	50%
Total	30	100%

D. Sampling Procedure

Purposive was utilized to select both groups of respondents. Purposive sampling is a non-probability sampling technique in which researchers intentionally choose individuals for inclusion in the study because of the characteristics they possess that make it likely they could contribute to the goals.

Purposive sampling is described by Kassiani Nikolopoulou as a "non-probability sampling method whereby participants are specifically selected based on their expertise or experiences."

E. Research Instruments

Two specific instruments were developed to obtain relevant information for this research, each specifically designed to meet the unique needs and backgrounds of the two respondent groups: plumbing professionals and student users. However, the same questionnaire was administered to both groups to ensure consistency in evaluating the model.

The tool was provided to individuals with technical experience in plumbing education as well as to students who utilized the model. It functioned as a feedback sheet to assess the prototype from a variety of viewpoints, including how well the model was constructed, how accurately it represented plumbing concepts, how well it satisfied the criteria for an instructional tool, and how unique the model was. The degree to which the participants agreed or disagreed with each question was scored on a four-point Likert scale, from Strongly Disagree to Strongly Agree. This format provided an easy method to collect numerical results and also gave participants the opportunity to add written comments where they could provide additional, possibly more detailed or critical, feedback about their experiences with the model. As such, this allowed the researcher to gather both quantitative data (e.g., whether the model worked as planned) and qualitative descriptions of how participants felt about the model, from both experienced instructors and students learning about plumbing.

Prior to finalizing the tool, it was piloted with a very small group to ensure that all of the language was clearly defined and that the layout was functional. Any needed modifications to the questionnaire were made based on feedback received during the pilot. Once completed, the tool was used to collect both quantitative and qualitative data to assess the general acceptance of the instructional tool and to identify any possible variations in perceptions based on the respondents' plumbing knowledge.

The scale below summarizes how both expert and students’ feedback was interpreted:

Table 2

Scale Point	Scale Point
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

To understand the overall acceptability levels, the following classification was used:

Table 3

Scale Point	Scale Point
3.50-5.00	Highly Acceptable
2.50-3.49	Acceptable
1.50-2.49	Unacceptable
1.00-1.49	Highly Unacceptable

F. Data Gathering Procedure

This research used an organized method and strong evidence-based practices to collect its information. All research methods began with developing the tools to collect the data. Those tools were not used until they had been tested on a pilot sample of five members in order to determine if the questions were clear and if they were asking the intended question. After the testing phase, the tools were revised as necessary to clarify and/or strengthen their purpose.

Once the tools had been developed, the researcher contacted two institutions: Quirino State University's Maddela campus and Nueva Vizcaya Sate University. The researcher requested permission from each school to conduct the study with the trainers and students of those schools.

In order to obtain expert feedback, the researcher contacted the plumbing instructors at the aforementioned institutions—7 from NVSU Bambang, and 8 from QSU Maddela. When meeting with the trainers, they were provided with a checklist to evaluate the model on four criteria: design and structure, functionality, sustainability and instructional potential. The trainers were also given the opportunity to provide free-writing feedback and suggestions for improving the model.

A suitable date was arranged for the researcher to present the model to the students and for the students to complete the survey. All students who participated were enrolled in Civil Technology courses. Students were asked to view the model and then rate it using a simple survey instrument. The study's survey had a few sections asking the students for their opinions on the different parts of the model. The survey also asked the students about their prior experience with plumbing to help determine if previous experience affected how they perceived the model. The survey consisted of many short answer questions where students could give their own thoughts, written answers for their opinions of the model.

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Prior to collecting any data, the researcher adhered to all applicable ethics standards. The researcher ensured that he received approval from the participating schools and that the participants understood the purpose of the study and what they were agreeing to by signing a simple consent form outlining their rights—including the right to discontinue participation at any time without consequence. Personal identifying information (including names) was never disclosed; all information remained confidential.

G. Statistical Treatment of Data

Weighted Mean. This was used to assess the respondents' overall views regarding the transparent house model in terms of design and structure, functionality, sustainability, and instructional potential.

Independent t-test. This was employed to compare the degree to which experts and students accepted the transparent house model based on the means of their respective assessments of the model.

The level of significance for this study was set at 0.05 alpha level.

4. Results and Discussion

The purpose of this chapter is to provide the results of the study and the supporting data for the conclusions as well as the analysis, interpretation, and discussion of the data collected using statistical techniques. The findings are also anchored on the development of students' competencies in identifying plumbing materials and installing waterline and wasteline systems. The tables and discussions are presented in the order of the problems identified in the first chapter.

Problem 1. What transparent house model could be developed based on the ADDIE instructional design framework (Analysis, Design, Development, Implementation, and Evaluation)?

Analysis. Students alike observed that plumbing components (pipes, etc.) were generally located inside walls and floor cavities of most residential construction projects. This resulted in students experiencing difficulty in comprehending the actual functioning of plumbing systems. Students were able to memorize plumbing vocabulary; however, when students attempted to apply this knowledge to a real-world plumbing system, they had difficulty visualizing the actual workings of the system. Student experience has been impacted by the current method of learning plumbing through field trips to different construction sites to view various plumbing configurations. Field trips to inspect different plumbing configurations have proven to be extremely time consuming. Additionally, gaining approval from school officials, arranging with the school's facilities department, and obtaining access to the hidden plumbing systems, presented numerous logistics issues which have made the process impractical.

To verify these claims, the researcher conducted a simple student survey with 30 students currently enrolled in Civil Technology 2 class. While students were able to memorize plumbing vocabulary, 21.90 percent rated their understanding of how plumbing systems operate in real buildings as Excellent, 9.40 percent rated it as Good, and 9.40 percent rated it as Fair. However, most students cannot apply this knowledge to a real-world plumbing system, they had difficulty visualizing the actual workings of the system, rating it 40.6 percent as poor.

The survey collected direct input from students concerning their experiences. Initial survey data indicated that approximately 59.4 percent of surveyed students rarely encounter practical examples or demonstrations of plumbing systems during the course. In addition, over 50 percent of surveyed students indicated that "limited exposure to real plumbing systems" was their challenge that they face in connecting theory to practice.

The data from the survey clearly supported previous research studies indicating the need for more effective, hands-on learning tools in technical areas. Santos and Cruz (2018) reported that vocational education students had difficulty understanding the conceptual relationships between plumbing and electrical systems due to the fact that many of these systems are not visible. Santos and Cruz (2018) further stated that traditional teaching methodologies are generally inadequate for providing students with a comprehension of complex systems. Similarly, De La Torre (2020), identified that students learn more about technical subjects when they utilize visual aids and interactive models. When students utilize visual aids and interactive models, they are able to make a greater connection between theoretical knowledge and application.

Additionally, several local research projects have demonstrated support for using interactive and visible educational tools in technical education. Manalo and Villanueva (2019) found that when visual aids (such as diagrams, or transparent models), were used in building classes; the amount of understanding on how buildings work was improved. Students became engaged in their learning process. Perez et al., (2021) conducted an experiment to test if three dimensional models are effective tools in teaching plumbing. The results showed students had a better opportunity to see what a plumbing system looks like than those students who did not use the 3D model. Thus, students could understand the material better.

The information collected from previous research suggested there was a need for an educational tool, which would allow students to visualize the working of a plumbing system. This educational tool would also aid in developing the skills associated with recognizing plumbing materials and completing waterline and waste line installations. The transparent house model is one form of this educational tool and would allow students to interactively view and understand the internal functioning of a plumbing system and enhance their conceptual knowledge and practical application of these skills. (p.10) (p.11).

Design. Following the identification of the challenges encountered by students, the development of a model capable of addressing those challenges became the next step. During this time, the researcher was developing the model while attempting to create a simple diagrammatic representation of how piping lines are laid out within a bathroom. By designing the model in a clear manner and by organizing components (supply lines, drain/vent lines, pipe fittings & fixtures) into a logical sequence for the students to understand, the researchers believed they had created a basic framework. Designers selected materials from available options that were durable, transparent and offered ease-of-access and therefore would be suitable for the classroom environment. In addition to providing an easy-to-use model, the researchers also made sure that the model was partially movable allowing instructors to easily move the model around in the classroom to teach as needed. Additionally, the plumbing layout contained within the model followed the same guidelines and standards as those employed by TESDA during assessment, thereby ensuring alignment with established best practices.

Development. Upon completion of the design, the Development Phase of the project involved creating the actual model based on the conceptual plan developed in the Design Phase. The Development Phase began by developing the walls, floors and roof of the model. All of the panels were measured and cut to allow for full view of plumbing components from desired angles. Each component of the assembled model was evaluated for stability to ensure the model could sustain repeated use in the classroom setting.

Once the structural framework of the model was complete, the plumbing layout was installed in a manner consistent with typical residential plumbing layouts. Tubes of various colors and clarity were used to represent supply lines versus waste lines; this would assist the student in understanding which direction the line went (i.e., which fixture) and what its purpose was. Plumbing fittings (elbows, tees, reducers, traps and connectors) were installed according to typical plumbing practices to create an environment that would both be visually understandable and technically accurate.

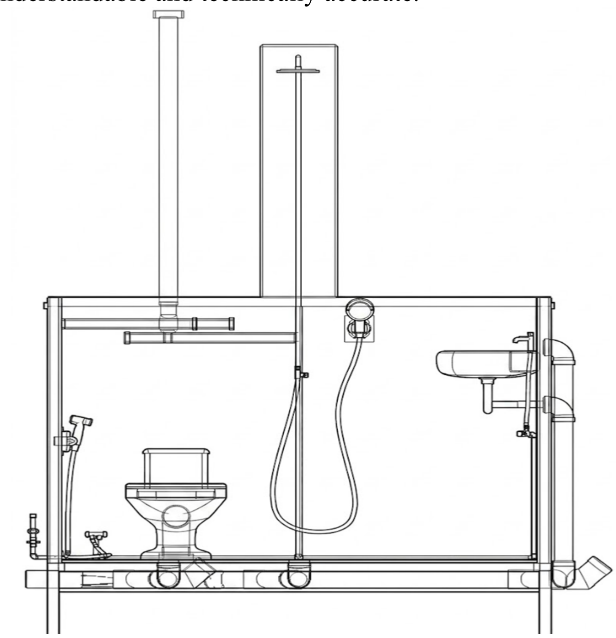

Fig. 2. Functioning of a plumbing system

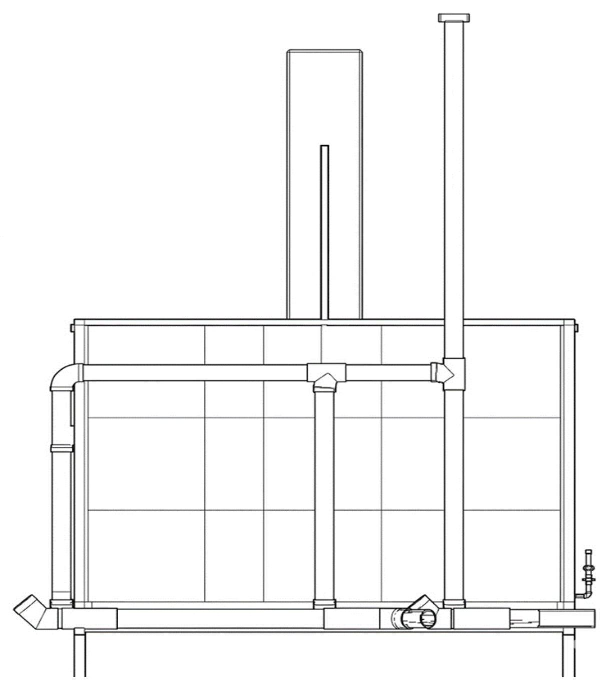

Fig. 3. Internal functioning of a plumbing system

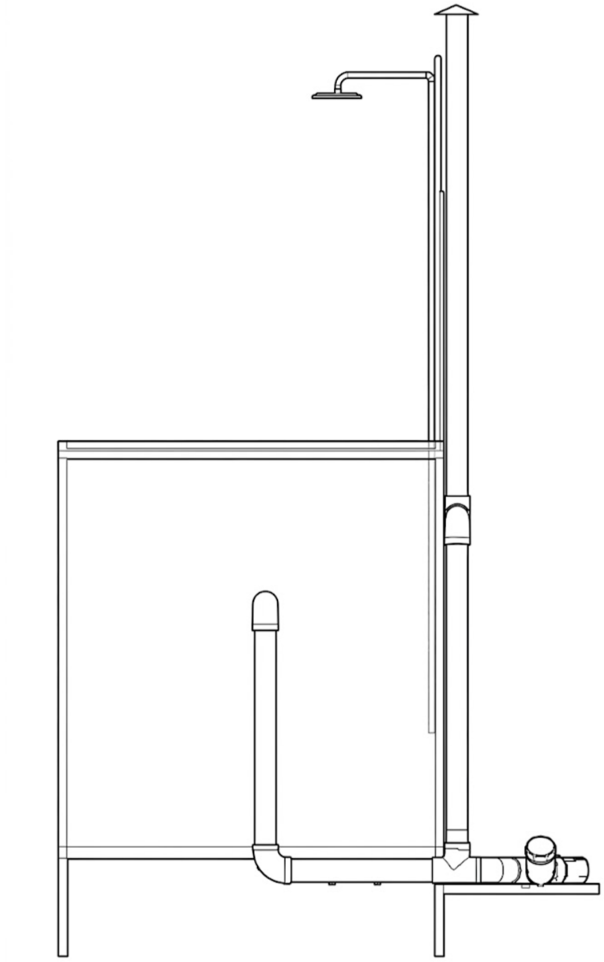

Fig. 4. Internal functioning of a plumbing system

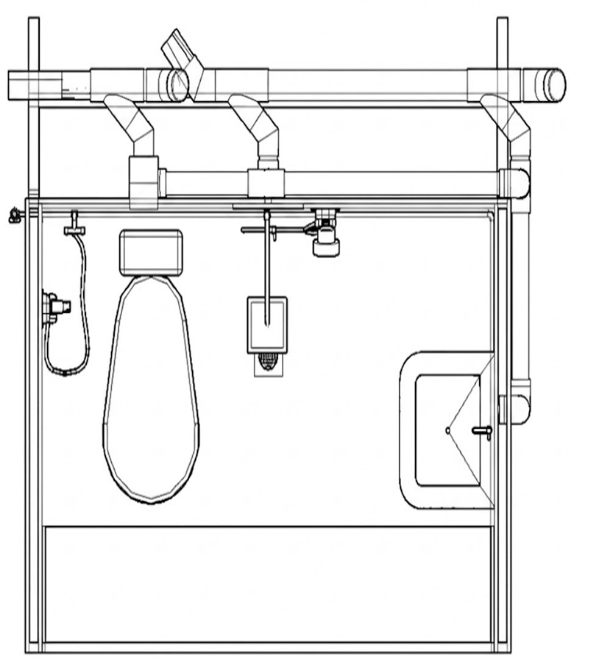

Fig. 5. Functioning of a plumbing system

The Development Phase, as well as installing the plumbing parts, incorporated miniature versions of residential dweller type common fixtures (toilets, sinks, etc.), to help students visualize how each fixture is related to the total system. Labels were provided on the model for the purpose of helping students identify the various components of the model but did not provide an excessive amount of details about their operation. Finally, flow tests were performed to verify that water flowed smoothly through the system; this would allow the instructor to provide a visual example of the actual movement of water through the system which is typically not seen by the student in their regular lecture format.

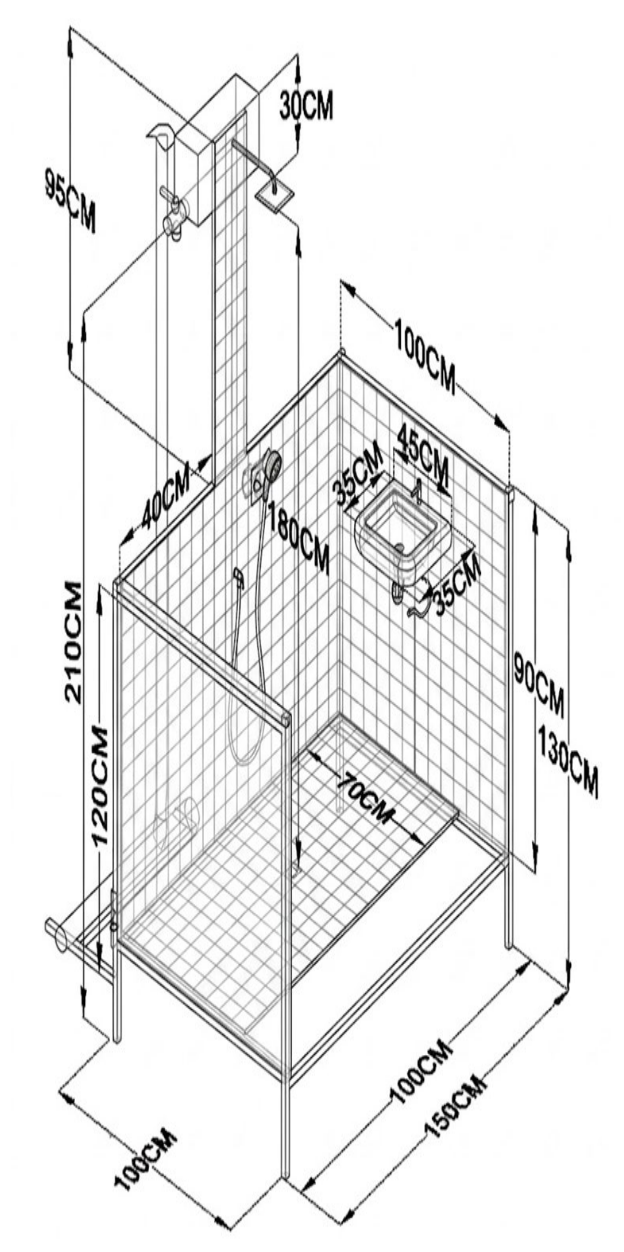

Fig. 6. Installing the plumbing parts

Fig. 7. Development stage

Several modifications were implemented during the development phase to increase clarity and usability. A few of the lines were moved to better display the componentry and some of the components were strengthened to extend the life of the model. Upon completion of the development phase, the transparent house model became a fully operational demonstration tool that allowed students to learn about plumbing systems within the classroom rather than requesting long periods of time to build models, obtain permission from school administrators, or schedule field trips to view actual waste lines and connections.

Implementation. After the development stage, the next phase was the actual use of the transparent house model in a classroom. Both students and experts were introduced to the model. It demonstrated how water flows through the supply and waste lines and how the different plumbing components work together. The participants had the chance to observe and interact with the model. This allowed them to see how the instructional tool functions in a real learning environment. During this process, the model served as a visual and hands-on teaching aid. It helped learners better connect theoretical knowledge with practical application before evaluation.

Fig. 8. Development stage

Fig. 9. The transparent house model in a classroom

Evaluation. Following the implementation of the transparent house model, a second phase in this study involved evaluating how well it functioned as an educational tool for students. The researchers used a pre-structured survey tool that included several categories for assessment (design/structure, functionality, sustainability and instruction). The student respondents utilized their direct experience and observation when assessing each category of the model. Data collected by the respondents were then statistically analyzed in order to measure acceptance levels of the model and identify whether any differences existed in the opinions of the two different respondent groups. These results were helpful in determining whether or not the transparent house model would meet its required technical and instructional criteria.

Problem 2. What is the level of acceptability of the developed transpPcsarent house model in terms of design and structure, *functionaPcslity, sustainability, and instructional potential?*

Table 4

Unit.	Quantity	Description	Unit Cost (Php)	Total Cost (Php)
Pcs	3	½" Female Elbow		
Pcs	3	½" Elbow	38.00	114.00
Pcs	2	½" Tee	27.00	54.00
Pc	1	½" Female Tee	47.00	47.00
Pc	1	½" Coupling)	15.00	15.00
Pc	1	½" Union Patente	54.00	540.00
Pc	1	½" Ball Valve	75.00	75.00
Pc	1	¾" x ½" Coupling Reducer	40.00	40.00
Pc	1	1 Way Angle Valve	120.00	120.00
Pc	3	Flexible Hose (lavatory)	120.00	360.00
Pcs	1	3 Way Tee Valve	175.00	175.00
Pc	2	Male Coupling	15.00	30.00
Pcs	1	2 Way Angle Valve	200.00	220.00
Pc	1	Lavatory P-trap	11800	118.00
Pc	1	High Arc Faucet (sink)	200.00	200.00
Pc	1	Shut Off Shower Valve	350.00	350.00
Pc	1	2" P-trap Sanitary	118.00	118.00
Pc	4	2" PVC Tee	43.00	172.00
Pcs	1	3 x 2 Tee Reducer	82.00	82.00
Pc	3	2" Elbow 90°	55.00	165.00
Pcs	4	3" Elbow 45°	45.00	180.00
Pcs	2	3 x 2" Wye Reducer)	158.00	316.00
Pcs	1	3" Wye (PVC)	150.00	150.00
Pcs	2	3" Clean Out	170.00	340.00
Pc	1	3" 90° Elbow	55.00	55.00
Pc	1	Water Closet	2,501.00	2,501.00
Pc	1	Bathroom Sink	1,200.00	1,200.00
Pc	1	Shower Head	228.00	228.00
Pc	1	Floor Drain (stainless)	60.00	60.00
Pc	1	Bidet (sprayer set)	189.00	189.00
Pc	1	Handheld Shower Head	150.00	150.00
Pc	1	Soap Liquid Dispenser	99.00	99.00
Pcs	4	Lumber post 2.5" × 2.5" ×4".	120.00	480.00
Pcs	10	Braces 1.5" × 2.5" × 6"	120.00	1,200.00
Sheet	2	3/4" marine plywood sheet	1,300.00	2,600.00
Pcs	4	Caster with plate (heavy-dutyl)	60.00	240.00
Pcs	30	Vinyl tile	20.00	600.00
Liter	1	Exterior latex - blue	270.00	270.00
Set	20	Hex bolts & nuts + washers	24.00	480.00
Set	1	Baby roller	50.00	50.00
Pc	2	Sandpaper (#80)	20	40
Pc	1	Paintbrush (2")	40	40
Total				Php14,769.00

Table 5

Design and Structure	Experts		Students		Overall	
	Mean	QD	Mean	QD	Mean	QD
1.The prototype is built with, durable materials.	3.80	Highly Acceptable	3.66	Highly Acceptable	3. 73	Highly Accepted
2.The layout of plumbing components is neat and structured	3.66	Highly Acceptable	3.80	Highly Acceptable	3.73	Highly Accepted
3.The design shows the visibility of water flow and pipework.	3.66	Highly Acceptable	3.80	Highly Acceptable	3.73	Highly Accepted
4.The size and proportion of the prototype are suitable for classroom and laboratory use.	3.60	Highly Acceptable	3.53	Highly Acceptable	3.56	Highly Accepted
Sub Mean	3.68	Highly Acceptable	3.70	Highly Acceptable	3.69	Highly Accepted

Design anLiterd structure. Both student and expert respondents showed high levels of agreement on the acceptability of the Transparent House Model's design and structure, as demonstrated through their respective mean scores of 3.68 and 3.70. Both means indicate that the physical build of the model clearly supports the instructional standards required in plumbing education. The similarly high ratings indicate that the model has clearly represented the most important structural aspects necessary for demonstrating in Industrial Arts. As stated by Morrison, Ross, and Kemp (2019), an instructional prototype must achieve the right balance of realism and clarity to facilitate the cognitive processes related to instructional learning, an objective that was met based upon the respondents' evaluations.

The average score for the expert group was 3.80 and the student group was 3.66 on the first indicator, "the prototype is constructed with durable materials." Both the expert and student groups thought that this model is made of an extremely durable material that would endure repeated use by a teacher or student over time. When creating instructional materials there are several elements; however, durability of instructional materials is one of the most important. Technical vocational courses create many opportunities for teachers to interact with students, and therefore it creates an environment where instructional materials may be subject to heavy use, which makes durability even more crucial. Research also supports that using durable materials will extend the life of your instructional materials and save you money by reducing maintenance cost (Lucenario et al., 2016). The fact that the ratings were so high further illustrates that the materials selected for the model were in accordance with these known standards.

Scores for the other two indicators ("the structure of the arrangement of plumbing elements is well-arranged," "visibility of the water flow and piping are possible with the design") had similar means (3.66 to 3.80), categorizations of "Highly Acceptable." These findings illustrate that the model clearly, effectively organizes, and is easy to view the way plumbing systems work. Plumbing systems are difficult to visualize by students due to their invisibility; therefore, it is essential to be able to observe them when learning about an invisible mechanical system. Research on visual learning supports that organized spatial layouts enable students to follow the flow of systems and the connections of components to one another; this improves students' ability to understand concepts and reduces their cognitive load (Mayer, 2017). The high level of agreement from both groups supports the fact that the model effectively addresses the need for visibility by allowing the observation of pipework and water flow.

The last indicator ("The size and proportions of the prototype are suitable for classroom and laboratory use"), however, was evaluated as less highly accepted (mean score of 3.60 for experts and 3.53 for students). Although the rating for this indicator was lower than the others, it is still considered to be a highly acceptable evaluation. Therefore, although there may be some variation in terms of how the size and proportions of the model were evaluated, the high degree of acceptance suggests that the size and proportions of the model provide sufficient space for group demonstrations, are mobile and easy to store, all of which are factors discussed in the literature related to instructional design. In particular, studies on classroom-based models stress that educators should find a balance between portability and visibility such that the tool is easily accessed while still providing a visible display of the function of each component (Bautista & Roque, 2022); therefore, it appears that the model strikes a balance in this regard.

Overall, the average of the subscores across all of the indicators (3.69) indicates that both groups believe the Transparent House Model has been well-planned and developed to meet the structural needs for instruction in plumbing education. The findings of this study support the idea that the model's materials, layout, visibility features, and dimensions support effective teaching and learning. Overall, the findings of this study support those of other studies that demonstrate that well-developed physical models aid in the development of conceptual understanding, promote learner engagement and support the acquisition of procedural knowledge in technical-vocational fields (Flores, 2022).

Table 6

Functionality	**Experts**		**Students**		**Overall**	
	Mean	QD	Mean	QD	Mean	QD
1. The prototype demonstrates how real plumbing systems function.	3.86	Highly Acceptable	3.73	Highly Acceptable	3. 79	Highly Accepted
2.The components operate properly and are easy to identify.	3.86	Highly Acceptable	3.86	Highly Acceptable	3.86	Highly Accepted
3.Key components (e.g., traps, vents, valves) operate correctly.	3.66	Highly Acceptable	3.66	Highly Acceptable	3.66	Highly Accepted
4.The prototype represents both supply and drainage systems effectively.	3.73	Highly Acceptable	3.53	Highly Acceptable	3.63	Highly Accepted
Sub Mean	3.78	Highly Acceptable	3.70	Highly Acceptable	3.74	Highly Accepted

Functionality. Results demonstrated that both groups were extremely favorable about the functionality of the Transparent House Model, indicating a combined mean of 3.74. These uniformly high scores suggest that both groups perceived the model to be a very effective tool for illustrating how plumbing systems perform in real life. Functionality is essential in instructional design, since a model does not only need to display all the component parts of a system, but it needs to operate in a manner that replicates real world system performance.

According to Tessmer and Wedman's (2016) principles of prototype evaluation, a functional model must accurately represent and simulate real world processes, a requirement that was achieved based on the perception of the respondents.

Statement number one stated "the prototype demonstrates how real plumbing systems function," which had a mean rating of 3.86 from experts and 3.73 from students, both of which were classified as Highly Accepted. Therefore, it can be inferred that both users viewed the model as a realistic representation of how real plumbing systems actually functioned. Demonstrating an accurate representation of real systems is important to technical-vocational students who typically have difficulty learning abstract concepts. The literature states that using authentic simulations to teach technical skills increases competency, understanding and the application of those technical skills (Bernardo, 2017).

The second statement, "the components operate properly and are easy to identify," also had identical means of 3.86 for both expert and student raters, and the highest and most consistent rating in the group. The consensus of both groups regarding the ease of identification and operational quality of the model's parts is indicative of a very good instructional tool. The importance of identifying individual components is significant because it allows students to establish connections between nomenclature and actual physical structures. The literature has shown that clear and easily identifiable componentry leads to better recall and increased conceptual mastery in the areas of engineering related education (Mayer, 2017). The consistency of both expert and student ratings further emphasizes the model's ability to achieve this objective.

The mean score for the third question ("Key Components (e.g. Traps, Vents, Valves) Work Properly") was the same for both Expert and Student Raters at 3.66, which is classified as Highly Acceptable. While both groups felt the Key Components were working properly, both groups also gave this question slightly less of a rating than Questions 1 & 2. This high rating does indicate that the model works as it should be expected to work in addition to being a good indicator that all critical plumbing mechanisms are functioning as they should. Technical-Vocational Educators have placed an overwhelming emphasis in the past on ensuring that all key components of a given system operate as they should be, so that their students do not develop misconceptions about how systems work and can obtain solid procedural knowledge regarding how systems work (Flores, 2022).

The fourth statement, "the prototype represents both supply and drainage systems effectively," received 3.73 from experts and 3.53 from students, for a total mean of 3.63. While this is the lowest rating of the four indicators, it remains in the Highly Accepted category. This suggests that both groups recognized that the model represented both water supply and wastewater disposal systems as a complete system, a necessary aspect of demonstrating a complete understanding of plumbing system operations. As noted in the literature, instructional models that include integrated systems (i.e., not isolated parts) are more effective at providing students with a comprehensive understanding of processes (Bautista & Roque, 2022). The positive evaluations of the model indicate that the model was successful in demonstrating this holistic approach.

The overall average of 3.74 for the functionality indicator confirms that the Transparent House Model not only visually appears to be a structurally sound model, but it also performs as expected in terms of simulating real plumbing operations. It demonstrates real plumbing operations, includes moving water flow and demonstrates the correct behavior of traps, vents and valves, all of which will enable the model to support learning that aligns with real-world applications.

Sustainability. These findings show that respondents have collectively accepted the prototype as an environmentally responsible, maintainable, resource-efficient and reusable instructional tool, all qualities necessary for tools intended to last many semesters/years. In educational material development, sustainability is an important consideration since the goal is to develop tools that will last many semesters/years and not require replacement after short periods of time which would produce unnecessary waste.

The first indicator, “the materials used are environmentally friendly and reusable” received an average score of 3.66 from the experts and 3.93 from the students; therefore, an overall average of 3.79, which we interpret as Highly Accepted. The responses reflect the respondents' belief that the prototype employs materials that are suitable for continued reuse with minimal environmental impact. Flores (2020) points out that when educational institutions begin using sustainable and recyclable materials in their educational materials, the institution's role in maintaining ecological integrity increases and students' environmental awareness is enhanced. Therefore, the strong positive scores illustrate how the model has met this principle through the transparent design of its components which are both durable and reusable.

The second indicator, “the design allows for easy repair or component replacement” obtained a high average of 3.86 from the experts and 3.46 from the students, resulting in an average of 3.66. The fact that the design of the prototype lends itself to being repaired or having components replaced without needing to be completely rebuilt indicates that the respondents believe the design is easily repairable. Repairing instructional tools is widely considered a fundamental principle of sustainability since it minimizes the amount of waste generated and prolongs the life of the tool. Bautista and Roque (2022) emphasize that the use of modular and repairable designs in educational innovation not only saves institutions money by reducing repair costs, but promotes efficient resource management. The positive scores indicate that the model incorporated these features.

Table 7

Sustainability	Experts		Students		Overall	
	Mean	QD	Mean	QD	Mean	QD
1. The materials used are environmentally friendly and reusable.	3.66	Highly Acceptable	3.93	Highly Acceptable	3. 79	Highly Accepted
2. The design allows for easy repair or component replacement.	3.86	Highly Acceptable	3.46	Highly Acceptable	3.66	Highly Accepted
3. The system is water-efficient and does not waste resources.	3.73	Highly Acceptable	3.40	Highly Acceptable	3.56	Highly Accepted
4.The prototype can be stored, transported, and reused.	3.60	Highly Acceptable	3.60	Highly Acceptable	3.60	Highly Accepted
Sub Mean	3.71	Highly Acceptable	3.60	Highly Acceptable	3.65	Highly Accepted

The third indicator, “the system is water-efficient and does not waste resources” received averages of 3.73 (from experts) and 3.40 (from students); therefore, an overall average of 3.56; again, Highly Accepted. The respondent's perception that the model demonstrated plumbing operations without wasting water illustrates that the respondents believe the model demonstrates water-efficient plumbing operations. It is imperative that vocational-technical programs teach systems in a responsible manner. Research on sustainability emphasizes the need for educational models that utilize resource-efficient methods for demonstrating mechanical or fluid processes in order to ensure that educators use educational models in a responsible and safe manner (Lucenario et al., 2016). The positive evaluations confirm that the model balanced functionality with resource conservation.

The fourth and final indicator, "the prototype can be stored, transported, and reused", was evaluated similarly by both the expert and the student respondents, both averaging 3.60 and interpreted as Highly Accepted. The similarity of the two groups' scores reflects that there was a significant degree of consensus among respondents that the model's design facilitated its portability and durability, key factors for developing school-based instructional materials for demonstrations that may be used in multiple classrooms, multiple locations, and for multiple academic years. Morrison et al. (2019) often identify portability and reusability as critical sustainability aspects because both facilitate the use of instructional materials in various classrooms, environments, and time frames. The similar ratings from both groups of respondents demonstrate that the model met the expectations associated with both of these aspects.

Collectively, the indicators used to evaluate sustainability had an average of 3.65. Overall, the ratings reflect that the Transparent House Model is both functional and visually understandable, and most importantly, that it is durable, maintainable, resource-efficient and designed for extended use. Like the studies of Connelly and Galli (2019), sustainable learning materials are shown to improve institutional efficiencies and foster environmental responsibility without diminishing instructional quality. These data demonstrate that the prototype is a well-developed, sustainable instructional material that is appropriate for continuous use in industrial arts plumbing education.

Instructional Potential. It appears that both experts and students have overwhelmingly positive opinions regarding the educational utility of the prototype model, based on the results of the survey data. Experts gave an average rating of 3.68, whereas students provided an average rating of 3.63. The fact that experts gave a slightly higher average rating than students, yet both still indicated their belief that the prototype has sufficient relevance and alignment with the needs of plumbing education, supports the notion that the design and content of the prototype model is successful in matching the intended curricular objectives. This is supported by the view that to be effective, instructional tools must directly support the intended curricular goals (Torres & Hernandez, 2021).

Both expert and student respondents indicated that they believe the prototype model effectively illustrates fundamental and advanced plumbing concepts and had a high level of acceptance for this aspect of the model, with an overall average rating of 3.53. The evidence from these findings suggests that the prototype serves as an adequate visual and experiential learning tool, facilitating a greater ability to visually and physically comprehend technical concepts. Several recent studies have demonstrated that hands-on or visual instructional tools provide greater conceptual clarity and facilitate practical application, particularly in technical-vocational subject areas (Delos Santos & Rubio, 2022).

Furthermore, both expert and student respondents provided ratings that exceeded 3.6 for the prototype's ability to promote engagement. These findings suggest that the model is seen as interactive by the learners and beneficial to encouraging participation by the teachers. Previous research has demonstrated that instructional materials that permit direct observation and manipulation are able to greatly enhance student motivation and participation in skill-based subject areas (Bautista & Cruz, 2023).

Finally, both expert and student respondents indicated that the prototype model is highly effective in enhancing teacher effectiveness in explaining plumbing systems, with one of the highest mean ratings (experts: 3.86; overall: 3.73). These findings reinforce previous views that instructional models designed to meet specific educational requirements can assist in simplifying complex processes and enhance the efficiency of instruction. Previous research has demonstrated that instructional models that are clear and functionally effective can assist educators in delivering lesson plans more efficiently and assist in developing a greater understanding among the learners, ultimately improving performance (Reyes, 2022).

Table 8

Instructional Potential	Experts		Students		Overall	
	Mean	QD	Mean	QD	Mean	QD
1. The development and evaluation of the prototype aligns with course outcomes for plumbing education and among industrial arts students.	3.73	Highly Acceptable	3.73	Highly Acceptable	3. 73	Highly Accepted
2.The prototype shows demonstration of both basic and advanced plumbing concepts.	3.46	Highly Acceptable	3.60	Highly Acceptable	3.53	Highly Accepted
3.The development and evaluation of the prototype encourages student interaction and engagement.	3.66	Highly Acceptable	3.60	Highly Acceptable	3.63	Highly Accepted
4.The prototype enhances teacher effectiveness in explaining plumbing systems among industrial arts students.	3.86	Highly Acceptable	3.60	Highly Acceptable	3.73	Highly Accepted
Sub Mean	3.68	Highly Acceptable	3.63	Highly Acceptable	3.65	Highly Accepted

Table 9

Indicator	Group	Mean	Remarks
Design and Structure	Experts	3.68	Highly Acceptable
	Students	3.70	
Functionality	Experts	3.78	Highly Acceptable
	Students	3.70	
Sustainability	Experts	3.71	Highly Acceptable
	Students	3.60	
Instructional Potential	Experts	3.68	Highly Acceptable
	Students	3.63	
Overall	Experts	3.71	Highly Acceptable
	Students	3.65	

The average score of 3.68 on the evaluation scale shows that design/structure, functionality, sustainability and instructional value were all very acceptable by both experts and students. Overall, the model was rated positively as meeting the major criteria required to be considered an instructional innovation in the area of industrial arts. The model met these criteria at a level that is indicative of success in addressing the instructional barriers which were identified through the Analysis phase. According to research in instructional technology, effective instructional materials are those that resolve current instructional barriers while increasing student interest (Reigeluth, 2016), the model does this by providing visualization, accessibility and functionality.

Additionally, the similar responses from both expert and student respondents indicate that the model has instructional value both from a teacher's perspective and the students. Studies have indicated that when there is a positive correlation between what teachers and students perceive to be the instructional value of a particular resource or method of instruction, it indicates a stronger instructional value (Lopez & Javier, 2019) for that resource/method. This consistency provides a stronger credibility base for the acceptability of the model.

Finally, since the model is acceptable across all areas (design, function, usability and instructional value) it is ready to be incorporated into classroom instruction. As previously stated, tools that have high scores in multiple areas of evaluation (e.g. design, usability, instructional value etc.) are more likely to have a significant positive effect on student learning (Santos, 2020), thus the model fits this description.

Overall, the results of the acceptability study demonstrate that the Transparent House Model is a well-designed, functional, sustainable and instructionally effective tool that positively impact student learning in plumbing and industrial arts education.

Problem 3. Is there a significant difference between the evaluation of the experts and industrial arts students?

In order to determine if there are significant differences in the evaluation of the two group of respondents of the Transparent House Model in terms of its design and structure, functionality, sustainability, and instructional potential, the mean differences of the two groups were compared using the independent t-test. Results are presented in table 10

Design and structure. There was no statistical significance found when comparing the evaluations of both student and expert assessors concerning the design and structure of the Transparent House Model. Both the evaluation of experts and students averaged approximately 3.7. The calculated t-value of -0.21 and p-value of 0.83 indicates there is no statistical significance in the differences in assessments made by both assessor groups. Therefore, both assessor groups viewed the model similarly. This agrees with research indicating that successful instructional tools will have to meet both the professional standards and the user expectations for them to be successful (Yang et al., 2020).

The absence of a statistically significant difference in assessments made by assessor groups indicates that the structure and design of the prototype were acceptable to all assessor groups regardless of assessor group experience. Assessments made by experts included comments on the durability, neat layout, and appropriate size of the model. Student comments regarding the same attributes also indicated appreciation of these attributes, thus further highlighting the acceptability and instructional value of the model. Literature in the field of technical vocational education has established that models with clear designs and an accurate representation of actual systems enhance learning through their aesthetic appeal and functional clarity (Swisscontact, 2024; Mariano & Dizon, 2023). Consistent assessment of the prototype demonstrates that the prototype successfully combines technical accuracy with accessibility for students which is a key consideration when developing instructional materials.

The consistency in how assessment was made by both assessor groups clearly indicates that the model is reliable for use as an educational teaching tool. When two different assessor teams view the design and format of the prototype favorably, it demonstrates that the prototype exhibits key elements of good Instructional Design; specifically Structural Integrity, Visual Clarity, and Learner Focus (Delos Santos & Aquino, 2021). The results also provide evidence to support the

Table 10

Criteria	Group	Mean	Computed t-value	p-value	Remarks
Design and Structure	Experts	3.68	-0.21	0.83	Not Significant
	Students	3.70			
Functionality	Experts	3.78	0.97	0.37	Not Significant
	Students	3.70			
Sustainability	Experts	3.71	0.88	0.42	Not Significant
	Students	3.60			
Instructional Potential	Experts	3.68	0.56	0.60	Not Significant
	Students	3.63			
Overall	Experts	3.71	1.25	0.21	Not Significant
	Students	3.65			

idea that well-constructed and durable models can help reduce students' confusion and improve their understanding. The importance of visual and hands-on representations of technical subject matter cannot be overemphasized (Navarro, 2022). In general, the results of the t-test demonstrate that the Transparent House Model is both technically correct and suitable for instruction with an extremely high degree of acceptance among the assessor groups.

Functionality. The evaluation by both experts and students of the functionality of the Transparent House Model using a t-test showed that both evaluator groups had very high ratings for the prototype. Experts provided an average rating of 3.78 to the prototype while students provided an average rating of 3.70 for the same model. The calculated t-value was 0.97 and the calculated p-value was 0.37. These values indicated that the difference between the two evaluator groups were not statistically significant, since the calculated p-value (.37) exceeded the .05 threshold at which the null-hypothesis would be rejected. Therefore, based upon these values, the null-hypothesis would be accepted, and since both groups evaluated the model in a similar and positive way, it is reasonable to conclude that both evaluator groups positively viewed the model's functionality. Since there is no statistical difference between the two evaluator groups in terms of their positive views of the model's functional aspects, the model's functional features such as operational components, accurate depiction of the supply and drainage systems within the model and ease of identification of the model's key components, are viewed as successful by both evaluator groups. This finding supports previous studies by Delos Santos and Aquino (2021), where they found that functional or transparent models can enhance learner's understanding of the mechanism of systems, and by Aquino and Del Mundo (2022), where they stated that real-world functionality in instructional materials enhances the clarity of teacher explanations and the comprehension of students. Both expert and student evaluator groups also agreed that the prototype accurately represents real world plumbing systems thereby enhancing the prototype's effectiveness as a hands-on teaching tool.

In conclusion, the results from the t-tests suggest that the Transparent House Model has been well-received in terms of functionality by all evaluator groups. The consistent ratings from both experts and students support the reliability and educational importance of the model and show that the model clearly and unambiguously conveys plumbing concepts. These findings provide further evidence that we accept the null-hypothesis, which validates that there is no statistical difference in perception of the two groups of evaluators, and further supports the notion that the prototype is functionally complete and educationally suitable Navarro (2022)

Sustainability. The t-test comparing expert opinions to student evaluations of the Transparent House Model demonstrates that each group has positive views of the prototype. Experts rated the prototype with an average score of 3.71; students rated it at 3.60. The t-statistic was found to be .88; the associated p-value is .42. Since the p-value exceeds .05, the null hypothesis can't be rejected. That indicates there are no differences between how students and experts evaluate the prototype. Therefore, both groups have agreed upon which elements of the prototype represent aspects of sustainability, i.e., sustainable material selections, water conservation, reuse capability and easy storage or transportation.

The fact that both groups rated the prototype similarly, indicates that the prototype successfully incorporates the sustainable design principles identified by both groups. Literature about the development of instructional devices emphasizes the importance of utilizing sustainable, reusable materials when developing instructional devices, thereby increasing both the educational and practical utility of the device (Swisscontact, 2024; Reyes et al., 2022). Both expert and student respondents also stated that the model's design allows for the repair or replacement of components. This corresponds to the best practice for longevity and resource efficiency in technical/vocational education (Mohammed & Omar, 2020).

In conclusion, the results support that the Transparent House Model is well accepted concerning its sustainability. The lack of statistical significance in rating differences between experts and students demonstrates that the prototype meets both professional and learner expectations for the use of environmentally friendly and resource conscious design. Therefore, we accept the null hypothesis that the perception of sustainability is consistent across both groups. Furthermore, this supports the validity of the model's design and practical applications (Delos Santos & Aquino, 2021; Navarro, 2022).

Instructional Potential. The t-test of expert and student evaluation of the instructional value of the transparent house model indicates that both groups of evaluators evaluated the model positively, i.e. they evaluated the model highly. The experts' average rating was 3.68 and the students' average rating was 3.6. The t-value calculated from the data was 0.56, and the p-value was .60. Therefore, since the p-value is greater than the 0.05 alpha level, we will reject the alternative hypothesis and instead adopt the null hypothesis, implying that there are no statistically significant differences in the ratings of experts and students. Both groups seem to perceive the model in a similar way regarding how the model can be used as a teaching tool or learning resource.

High correlation between experts and students reflects that the prototype fulfills the objectives of teaching and learning. The prototype illustrates basic and advanced plumbing concepts, enhances the teachers' ability to explain the subject matter, and stimulates students' interest in the subject matter. There is research that supports these findings, which have demonstrated that a well-designed instructional model can increase students' understanding and participation in vocational-technical education (Yang et al., 2020; Delos Santos & Aquino, 2021), and models that are visually-oriented, related to the specific course material, and illustrative of abstract concepts are especially helpful to students, and allow teachers to teach more effectively (Reyes et al., 2022; Navarro, 2022).

Overall, the t-test results indicate that the Transparent House Model is considered by both sets of evaluators to be a valuable instructional aid. The minimal difference between the two means and the lack of statistical significance demonstrate that both the experts and the students believe that the model has merit as a useful teaching resource. These findings further emphasize the reliability, relevance to education, and usability of the model. The study confirmed that the model met the educational objectives for industrial arts students while meeting the professional standards of educators.

5. Summary, Conclusions, and Recommendations

This chapter provides a synopsis of the conclusions reached, and suggestions for the improvement of the Transparent House Model as an educational resource for students enrolled in vocational-technical programs. The chapter includes the results from the evaluation (acceptance) of the model's functional characteristics; sustainability; instructionally acceptable features; and results of data analyses. Suggestions are made based upon the results of this evaluation, so that it can be improved and used successfully in vocational/technical education.

A. Summary

The study aimed to evaluate the acceptability of the Transparent House Model as an educational resource for Industrial Arts students at Quirino State University, Maddela Campus. Specifically, it sought to determine whether the model effectively demonstrated residential plumbing systems, addressed design, functionality, sustainability, and instructional potential, and could serve as a practical tool for hands-on learning in technical-vocational training.

The research followed the ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation) to guide the planning, creation, and validation of the model. A functional transparent house prototype was developed to visually demonstrate standard residential plumbing systems. Thirty respondents—including students, faculty, and plumbing experts—assessed the model using a validated, researcher-developed evaluation instrument. Descriptive statistics were used to calculate mean scores and degrees of acceptability, while an independent t-test compared acceptability ratings between respondent groups.

The following are the significant findings of the study:

1. The study developed a transparent plumbing system house model following the ADDIE instructional design model.
2. Experts and students both rated the Transparent House Model as Highly Acceptable. They agreed on its durability, clear layout, and visibility of water flow, which contributed to its effectiveness as a learning tool. The model received high ratings in design and structure (Experts = 3.68; Students = 3.70), functionality (Experts = 3.78; Students = 3.70), sustainability (Experts = 3.71; Students = 3.60), and instructional potential (Experts = 3.68; Students = 3.63).
3. There is no statistically significant difference in the rating of both the experts and students.

B. Conclusion

Based on the foregoing findings, the following conclusions were drawn:

1. Through analysis, design and development of the application of the modified framework, a transparent plumbing system house model was designed. The final version of the prototype provides all the necessary requirements to be considered an effective instructional material in technical-vocational education.
2. Both experts and industrial arts students evaluated the developed Transparent House Model very favorably in respect to its design/structure, functionality, sustainability, and instructional value. All two groups agreed that the model was well-organized; accurately represented the functions of a plumbing system; efficiently used resources; and had great potential for use in teaching plumbing skills.
3. There is no significant difference between the evaluation results of experts and industrial arts students on each of the four measures of acceptability. These findings confirm that both expert and student groups have a uniform and similar perception of the quality of this model (and thus its instructional value) and support the conclusion that the model is both technically-sound and meets the needs of learners equally well.

C. Recommendations

Premised on the significant findings and conclusions of the study, the following recommendations are offered:

1. The transparent house model is suggested as a key component in laboratory sessions and hands-on experiences for students to gain an understanding of piping systems, the behavior of water flow, and the function of the various components within plumbing systems; therefore, schools may provide teachers with worksheets or activity sheets to facilitate student engagement and increase student learning.
2. Teachers may incorporate the transparent house model into their regular instructional practices so they can demonstrate the layout of plumbing systems and the concepts of plumbing more clearly. Additionally, the model can be incorporated into competency-based assessments, problem-solving, and performance tasks by the teacher to ensure improved acquisition of skills.
3. TESDA trainers may integrate the transparent house model into TVET materials for plumbing NCII and associated qualifications as it is beneficial for the

presentation of skills such as pipe laying, drainage systems, and water supply components through modular instruction and practical demonstrations.

4. Curriculum planners may want to consider incorporating similar interactive and visual models in Industrial Arts and Technical Vocational subject areas as well as in future design of educational tools that utilize student-centered learning approaches and focus on functionality and visibility based on the results from this research.
5. Administrators may need to identify budgetary allocations to produce additional units of the model and similar educational materials to support hands-on, skills-based learning. Therefore, administrators need to purchase educational tools that are functional, durable, and sustainable to improve the quality of technical vocational education programs.
6. It is recommended that future researchers conduct qualitative studies to further examine the reasons behind the model's lower evaluation in terms of instructional potential. They may also consider developing improved versions of the model with detachable parts to allow easier practice and hands-on installation, thereby enhancing its effectiveness as a learning tool.

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