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Development and Evaluation of a Residential Plumbing Mock-up

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Abstract

The insufficiency of physical learning materials in Technical and Vocational Education and Training (TVET) often results in a purely theoretical approach that fails to equip students with industry-essential functional skills. This research developed and validated a residential plumbing mock-up as an instructional tool for the Plumbing NC II program at Mountain Province State University. Employing a sequential exploratory mixed-methods approach based on the ADDIE framework, the study first identified pedagogical gaps through thematic analysis of teacher and student perspectives, highlighting resource insufficiency and declining student interest. In response, a multi-functional residential plumbing setup was developed, incorporating water supply and Drain Waste and Vent (DWV) lines in strict accordance with the Revised Plumbing Code of the Philippines. The validation test produced a very high level of content validity (S-CVI/Ave = 0.94). The level of design quality was rated moderately to highly effective (6.19/7.0). The inter-rater reliability showed a fair level of consistency (ICC = 0.67). The level of acceptability tests among the students produced a Very Good level, specifically with regard to design (4.83/5.0). Additionally, a consideration of the STEEP (Social, Technological, Economic, Environmental, and Political) factors further established the importance of the usage of the proposed product for water conservation and the compliance with water policies. The conclusion of the validation test thus supports the proposed product as a very appropriate tool to strategically address the theoretical deficits present in the curriculum. The proposed product should thus be fully integrated into the curriculum and the replication of this developmental methodology to other technical disciplines to address the scarcity of resources.

1. Introduction

Providing a quality and meaningful learning experience to students is the primary objective of teaching and the core function of all learning institutions. Moreover, the attainment of universal access to high-quality education underpins the belief that education is among the most effective drivers of long-term development. This objective also aims to provide equitable access to affordable vocational training, eliminate gender and wealth disparities, and ensure universal access to high-quality higher education that is equitable, inclusive and provides

opportunities for lifelong learning for everyone (United Nations, 2015, as cited in "Goal 4: Quality Education," 2018).

To achieve quality education, course instructors must be innovative in delivering instruction to their students. To do this daunting task, instructional materials are needed to assist them in facilitating the effective learning of students. Among the much-needed instructional materials in technical vocational courses is the instructional trainer or instructional mock-up. The equipment offers students real life activities in their field of specialty during lab periods, and this is vital in terms of employment preparedness. In Kolb, Boyatzis, and Mainemelis (1999) Experiential Learning Theory (ELT), Kolb, Boyatzis, and Mainemelis postulated that ELT presents a comprehensive model of mature adult development, highlighting the key role experience plays in the process of learning. Their research points out that quality education is not only transmission of content but also includes the thoughtful design of learning environments, thoughtful selection and modification of learning materials, and the application of empirically grounded theories of learning. Instructional mock-ups can simulate real-life activities for students, in addition to assisting the course facilitator in modelling required competencies.

Over the years, mock-ups have existed as a representation method to clearly illustrate the features of a complex project in an easily comprehensible manner. Today, mock-ups are significant and useful tools for engineers and other design experts to project and present ideas, and they can serve as valuable learning materials in education (Bobadilla et al., 2016). Without this very important tool, the optimal result of the teaching and learning process cannot be achieved.

Mountain Province State University is offering the Bachelor of Technical-Vocational Teacher Education (BTVTED) program with five specializations: two under Technology and Home Economics, and three under Industrial Arts. Under the Industrial Arts, Construction and Civil Technology has Plumbing NC II as one of its core subjects. Since this subject entails hands-on training on residential plumbing system layout, installation, and maintenance, it is apparent that there is a need for an instructional mock-up which at present does not exist. Such a mock-up would enable students to watch, learn, and be engaged in the actual placement and installation of the different fixtures and pipes as required by the Revised National Plumbing Code of the Philippines for each housing unit. The effective imparting of such topics and their related activities cannot be achieved without such a practical tool. Currently, course facilitators resort to abstract presentations and infrequent site visits to construction areas with available plumbing works. Direct performance of laboratory activities is not consistently carried out, a significant concern that led the researcher to envision this project.

Evidence has shown the efficacy of instructional mock-ups to improve the performance of students along different parameters in technical vocational courses (Mustapha et al., 2024). For the plumbing course, an appropriate instructional mock-up may be developed to offer students realistic, experiential learning opportunities in the plumbing trade. Through the creation of this instructional mock-up, the existing gap in the teaching-learning process will hopefully be resolved. It can provide both the course facilitator and students with tangible instructional material to illustrate and manipulate various components, enabling them to acquire the required skills and abilities essential for their future teaching careers or industry work.

The main objective of this study was to design and develop a residential plumbing mockup to be used as an instructional material in teaching Plumbing NC II as a course in the BTVTED program. Specifically, it aimed to satisfy the following:

- Determine the challenges encountered by the teachers in teaching the Plumbing NC II course;
- Determine the challenges encountered by the students in learning the Plumbing NC II course;
- Develop an instructional mock-up to address the challenges encountered by the teachers and the students and determine the;
    - level of content validity; and
    - level of instructional design quality
- Determine the level of acceptability of the instructional mock-up in terms of:
    - design;
    - workmanship;
    - functionality;
    - user friendliness; and
    - safety.

2. Literature Review

2.1 The Challenge of Abstraction in Philippine TVET

These theoretical requirements notwithstanding, a number of systemic challenges beset the Philippine TVET sector. Recent studies have pointed out serious shortages in necessary instructional materials and equipment, as well as specialized teaching aids (Geraldizo & Dabasol, 2022; Orbeta & Corpus, 2024). Because of this shortage,

course facilitators are oftentimes constrained to giving the content in an abstract manner, with substantial use of PowerPoint presentations that assure rote memorization but not functional understanding (Reese, 2011). Lacking actual simulation equipment, students cannot develop the needed competency in the Plumbing NC II course.

Considering modern assistance, like the PSD software developed by Alhaji (2025), which greatly simplifies pipe sizing and the calculation of flow, these can by no means provide vocational training. They eliminate much mental burden of design but cannot simulate tool interaction and physical troubleshooting, which are necessary to acquire a trade.

2.2 The Mock-Up as a Pedagogical Tool

To address the scarcity of actual mock-ups, research has consistently confirmed the power of simulation-based education. For example, Mustapha (2024) observed that such environments greatly enhance learner performance in measurable benchmarks. Recent successful cases are the Portable Auto-Electricity Trainer developed by Lacanilao et al. in 2024, and the reinforced concrete floor slab mock-up of Wijayati and Suyatno in 2023. These studies confirm that properly structured mock-ups form a real, accessible, reproducible alternative to traditional site-based training.

2.3 Design Principles and Validation Framework

A plumbing mock-up is only an effective pedagogic aid if the devices are designed and built meeting design and safety criteria. Herrington et al. (2005) identified that for learning to be authentic, devices should be representative of the "real thing", have high levels of realism, functionality and part visibility. Based on Mayer's (2005) "modality" and "coherence" principles, elements are labelled in large letters and should be easily accessible to learners to avoid a high degree of cognitive load (Sweller, 1988). In addition, since OSH practices must be integrated into the curriculum for Plumbing NC II, the mock-up must also act as a safe simulation to experience workplace hazards under RA 11058. The process must also be systematically based on an educational model like ADDIE. As Basilio and Manalo (2023) show, expert validation on adequacy, coherence, and usefulness is rather necessary to ensure that the tool would not only be functional but pedagogically sound.

3. Theoretical Framework

The main objective of VET is to narrow the gap between the theoretical knowledge acquired in a classroom and the practical needs of the industry. This transition has its theoretical roots in progressive education in John Dewey's works dating from the years 1916 and 1938, where he had expressed that active learning would be about experience rather than merely passively receiving information. Reese (2011), describes this learning-by-doing as follows: students learn from the direct consequences of their actions, not by observing others or reading instructions.

Additionally, this is attested to by the constructivist theory, which asserts that meanings are created through active engagements. A concrete exercise is coupled with an instructional prototype to allow students to exercise complex plumbing systems, fostering cognitive knowledge through trial and error exercises. Robert Gagne's focus on instructional domains highlights that motor skills, similar to plumbing, require frequent coordination rehearsals to gain mastery. Consequently, the key to effective TVET provision will be found in the balance between theory and the repetitive, hands-on application made possible by simulation.

In addition, one of the aims of the science of instruction is on the development of effective instructional materials to illicit learning. Merril (2002) as cited by Khalil (2016), identified 5 principles of instruction that promote learning namely: 1. learners are engaged in solving real-world problems; 2. existing knowledge is activated as a foundation for new knowledge; 3. new knowledge is demonstrated to the learner; 4. new knowledge is applied by the learner; and 5. new knowledge is integrated into the learner's world.

These principles suggest that students learn more when new knowledge is demonstrated to them in the context of real-world tasks or problems. They learn more when they perform real-world tasks or solve real-world problems and receive feedback and appropriate guidance during that application. These principles can be used in task-oriented courses like those of the BTVTED major courses and must be considered in designing instructional mock-ups.

This study was guided by the ADDIE model of developing instructional materials. This model is appropriate because it is arranged with sequences of systematic activities in an effort to solve learning problems related to learning resources that follow the needs and characteristics of teachers and students. The ADDIE model provides opportunities at each stage of evaluation, the purpose of which is to minimize the level of product error in the final stage.

The ADDIE model consists of five stages, namely: (1) Analyze – the phase involves identifying and clarifying the instructional problem or, from a training standpoint, identifying the performance gap and desired outcomes. (2) Design -this involves defining objectives, strategies, and the content of the instructional material to ensure that

the gap is addressed, (3) Development – this involves assembling the prototype, integrating comments and suggestions, (4) Implementation – involves testing the prototype and collecting comments and suggestions for possible improvement, and (5) Evaluation – this involves now the content validity, instructional design quality and user acceptability evaluation process. The five stages of the development procedure above can be seen in Figure 1.

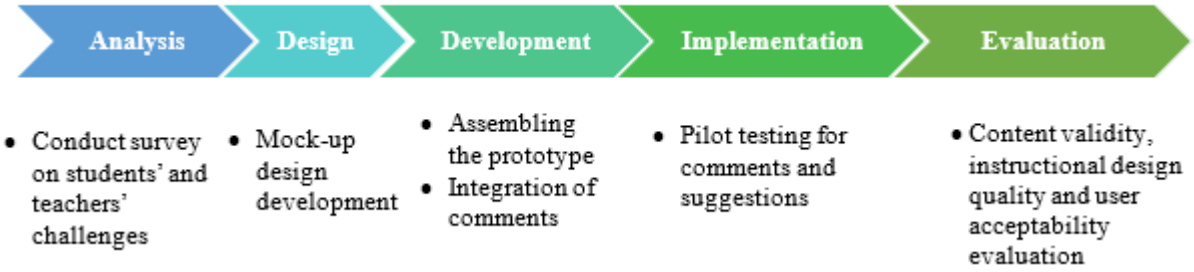


Fig. 1 *Paradigm of the study*

4. Materials and Methods

4.1 Materials

The residential plumbing mock-up is comprised of the minimum required number of fixtures as required by the Revised Plumbing Code of the Philippines. It is installed with 1 water closet, 1 lavatory/sink, and 1 shower installation. The water closet is a flush type with water tank, the lavatory is standard and the pipe connection to the shower are installed. The trainer also comes with a scaled down septic tank. Table 1 presents the used materials for the residential plumbing mock-up.

Table 1 *Bill of materials*

QTY	Material	Description	Unit Price	Total Price
1 pc	PVC	4" diameter	800.00	800.00
2 pcs	PVC	2" diameter	350.00	700.00
2 pcs	PVC	4" x 4" x 2" reducer wye	190.00	380.00
2 pcs	PVC	4" wye	190.00	380.00
2 pcs	PVC	2" P-trap	160.00	320.00
1 pc	PVC	2" sanitary tee	160.00	160.00
2 pcs	PVC	4" sanitary wye (4 x 2)	190.00	380.00
6 pcs	PVC	2" 45 degrees elbow	120.00	720.00
2 pcs	PVC	4" 45 degrees elbow	150.00	300.00
1 pc	PVC	4" clean out	190.00	190.00
1 unit	Water closet	Ceramic Water closet	4,000.00	4,000.00
1 pc	Toilet flange	Plastic	1,000.00	1,000.00
1 unit	Lavatory	Wall Hung Lavatory	2,000.00	2,000.00
1 pc	Marine plywood	¾" thick x 4' x 8'	2,000.00	2,000.00
4 kgs	Common nails	Assorted sizes (4", 3", 2 ½", 2"	150.00	600.00
3 pcs	G.I Tee	½" diameter	150.00	450.00
1 pc	G.I Coupling	½" diameter	120.00	120.00
4 pcs	G.I. Union	½" diameter	150.00	600.00
1 pc	G.I. Pipe	½" diameter	450.00	450.00
3 pcs	Teflon Tape		60.00	180.00
6 pcs	G.I. elbow	½" diameter, 90 degrees	120.00	720.00

QTY	Material	Description	Unit Price	Total Price
2 pcs	G.I. elbow	3/4" diameter, 90 degrees	120.00	480.00
2 pcs	Faucet	½" diameter	250.00	500.00
8 pcs	Caster wheel	Red PU Metal 4' diameter, swivel with lock	500.00	4, 000.00
1 pc	Plastic drum	200 liters	1,300.00	1,300.00
Total				**PHP22,900.00**

4.2 Methods

The study used a sequential exploratory design in a research and development (R&D) approach. This method guarantees that the creation of the residential plumbing mock-up was based on the qualitative needs assessment followed by quantitative validation. It constitutes the formative evaluation stage in the ADDIE process.

In terms of qualitative methodology, thematic analysis was used to uncover the issues experienced by both teachers and students. Meanwhile, in the quantitative method, a purposive sampling technique was conducted using eight technical experts, consisting of civil engineers and master plumbers, to determine the content validity of the instructional material. With regard to the user acceptability, a census of all nine (N=9) students currently taking the Civil and Construction Technology course at the MPSU-Tadian was considered. While the sample size is specific to the local institutional context, it represents a total-population census of the primary stakeholders for this instructional tool.

5. Results and Discussion

The primary purpose of the study was to gather information on the challenges encountered by instructors and students in the Plumbing NC II course as basis in developing an instructional plumbing mock-up. The output was subjected to an evaluation in terms of its content validity, instructional design quality and user acceptability as an instructional mock-up.

5.1 Challenges Encountered by the Teachers in Teaching the Plumbing NC II Course

Data from interviews with teachers and discussions with students showed three common themes about the challenges of the Plumbing NC II course. Both groups pointed out a significant gap between theoretical knowledge and the skills needed in the industry.

5.1.1 Challenges Theme 1: Resource Scarcity and Financial Constraints

A major challenge identified by both groups is the serious lack of available tools, equipment, and teaching materials. Teachers also pointed out that the tools they possess may be outdated or absent, so they spend their own money for the purchase of demonstration tools. Respondent 1 (Teacher) addressed the concern as he said, "*Our pay is not enough for us to pay for the materials needed*." When the materials used for demonstration are not available to the students, they resort to "*imaginations*" about how the pipe networks function. Additionally, the cost of buying pipes and fittings often falls on the students. Respondent 3 (Student) pointed out that this is unsustainable: "*We cannot provide for the materials... in effect, we did not see and experience connecting the pipes.*" This represents a major obstacle to the Competency-Based Instruction (CBI) model, which needs a lot of resources for effective learning.

5.1.2 Theme 2: The Inadequacy of Purely Theoretical Instruction

Both groups noted that relying solely on PowerPoint slides and videos is not enough for a skills-based course. Teachers use these methods as temporary solutions but admit that watching isn't the same as doing. Respondent 2 (Teacher) said, "*Watching and doing are two different things*." Students also pointed that although they could perform specific tasks like threading pipes, they did not understand how all the parts fit together in a home. A student said, "*We just imagine how the pipe networks look like... it should have been better if there is an actual mock-up to apply theories.*" This gap shows a clear need to develop a physical mock-up to connect theory with practice (Lacanilao et al., 2024).

5.1.3 Theme 3: Impact on Student Engagement and Interest

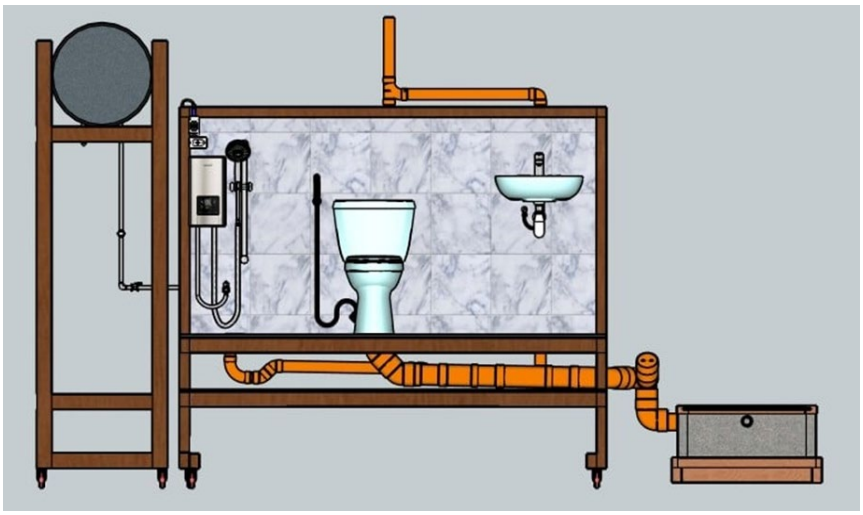
The data indicates a clear link between the lack of hands-on materials and decreasing student interest. Teachers observed that student enthusiasm drops when lessons turn into lectures. One teacher remarked, "*Students lose*

interest when I just present slides without an actual demonstration." Students respondents confirmed this by stating that not being able to see and practice real-life applications makes the lessons feel abstract and lacking.

5.2 Developed Mock-Up to Address the Challenges

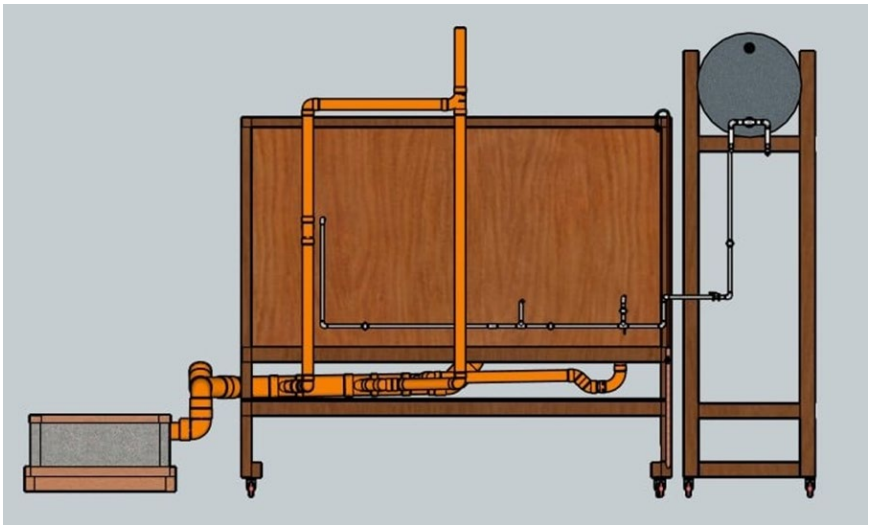
The design of the residential plumbing mock-up was based on the issues identified by Civil and Construction Technology teachers and students, aligned with the Plumbing NC II Training Regulations. To address the concerns on fixture connectivity, the design incorporated a complete single-unit system with a water closet, a lavatory, a shower, and DWV piping. It features a water supply network with a mini-storage tank and a miniature septic tank to demonstrate waste storage and treatment processes.

These elements demonstrate how a one-unit system operates based on a coordinated relationship, and thus is more easily understood by the student. The training model employs various fitting types in water supply installations to facilitate learning. A single-point shower heater is installed for simulated service, indicating typical residential installations today. Fixture and standard clearances are labeled for added information. A DWV layout can be readily modified for custom designs, enabling practice in measurement, cutting, threading, and troubleshooting. The mock-up developed is shown in Figures 2-6.



(a)

Fig. 2 *(a) Front view*



(b)

Fig. 3 *(b) Back view*

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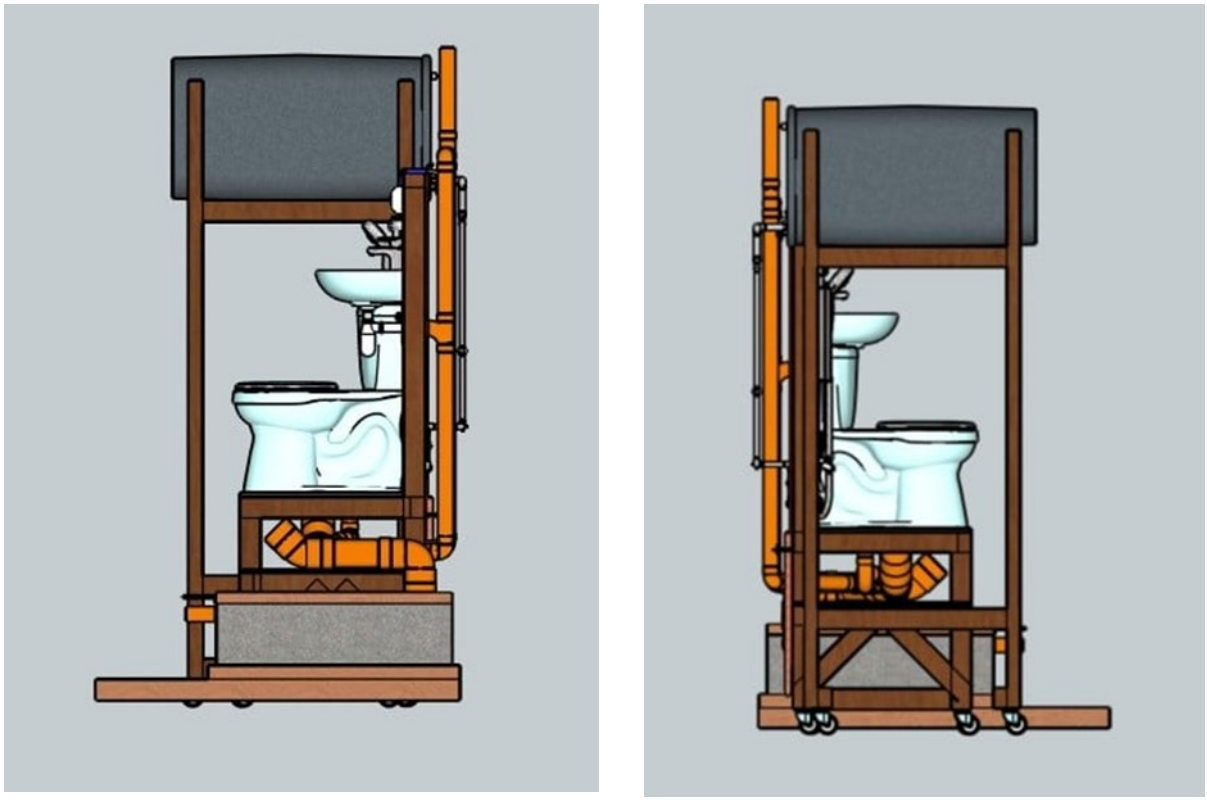
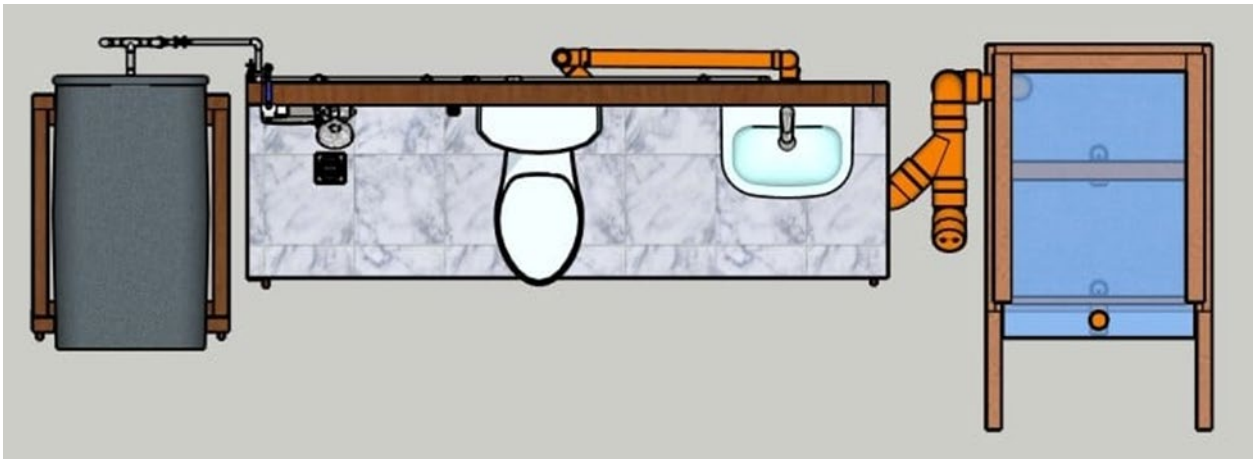


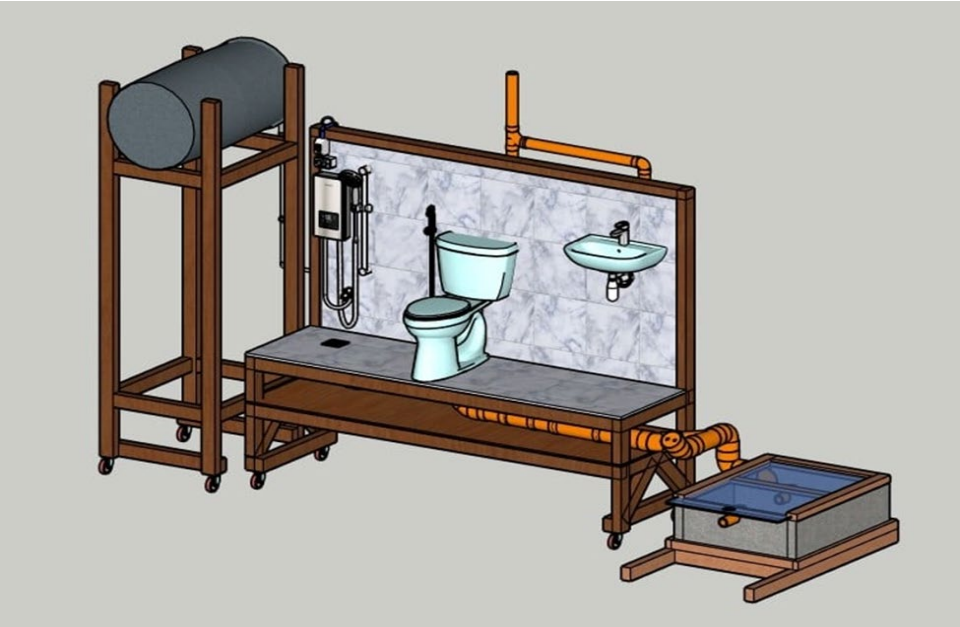
(c) **(d)**

Fig. 4 *(c) Right side view; (d) Left side view*



(e)

Fig. 5 *(e) Top view*



(f)

Fig. 6 *(f) Pictorial view*

5.3 Level of Validity of the Instructional Mock-Up

Content validity of the plumbing mock-up was thoroughly tested by a group of experts from the plumbing and civil engineering profession with long teaching backgrounds using a 4-point Likert scale. The level of content validity of the plumbing instructional mock-up is presented in Table 2.

Table 2 *Level of content validity*

Category	Mean	Standard Deviation	Level of Content Validity
Alignment with Learning Objectives	3.72	0.2	Excellent
Accuracy and Up-to-Date Information	3.59	0.25	Excellent
Comprehensiveness	3.72	0.11	Excellent
Realism and Authenticity	3.47	0.12	Good
Safety Standards	3.5	0.125	Good
Overall	3.62	.111	Excellent

The mean rating of Content Validity as Excellent (3.62) indicates the extent of the correlation between the conceptual quality of imagination-based learning in Section 5.1 with the needs of Plumbing NC II. The application of visuals in the mock-up represents the idea of Learning by Doing postulated by Dewey (1938) and reflects the First Principle of Instruction proposed by Merrill (2002). Namely, the mock-up helps to apply imagination during the phases of Application and Activation by letting learners not only observe but design DWV and water supply schemes.

As seen from Table 2, the validity levels of Alignment with Learning Objectives (3.72) and Comprehensiveness (3.72) highlight the pedagogical importance of using a task-based instruction model represented by the mock-up. Indeed, according to Merrill, learning happens when learners work on real-life issues. The change of intention solves the problem identified in Theme 3 (reduced student interest) as learners progress from memorizing the information to applying it actively. Additionally, the level of Accuracy and Up-to-date Information (3.59) confirms that the teaching material will be up to date and relevant to the Revised Plumbing Code of the Philippines. The content validity index for each items as indicated in Table 3.

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Table 3 *Content validity index for each item*

Category	Item	I-CVI (N=8)
Alignment with Learning Objectives	Specific Skill Practice	1
	Knowledge Application	0.875
	Troubleshooting & Diagnosis	1
	Performance Measurement	1
Accuracy and Up-to-Date Information	Technical Accuracy	0.875
	Industry Standards/Codes	1
	Tool & Material Representation	1
	Terminology Consistency	1
Comprehensiveness	Breadth of Topics	0.875
	Depth of Learning	1
	Essential Skills Inclusion	0.875
	Component Variety	1
Realism and Authenticity	Realistic Scale/Proportion	1
	Functional Simulation	0.875
	Material & Tool Feel	0.875
	Scenario Replicability	1
Safety Standards	Hazard Awareness	0.875
	PPE Encouragement	0.875
	Safe Work Practices	0.875
	Emergency Procedures	0.875

5.4 Level of Instructional Design Quality

Eight participants assessed the instructional design of the plumbing mock-up using a 7-point Likert scale across six criteria. The means from this assessment uniformly were very high: Workmanship/Aesthetics (6.50), Creativity/Innovation (6.25), Maintainability/Accessibility (6.25), Functionality/Performance (6.125), Safety/Code Compliance (6.125), and Efficiency (5.875). These consistently scores over 6.0 reflect strong evaluator consensus about the mock-up's outstanding quality or design excellence. These are summarized in Table 4.

Table 4 *Level of instructional design quality*

Category	M	SD	Level of Design Quality
Creativity/Innovation	6.25	0.46	Very Good
Functionality / Performance	6.13	0.64	Very Good
Safety / Code Compliance	6.13	0.35	Very Good
Efficiency (Water, Energy, Space)	5.88	0.64	Very Good
Workmanship / Aesthetics	6.50	0.53	Outstanding
Maintainability / Accessibility	6.25	0.46	Very Good

The higher than average mean scores for Functionality (6.13) and Creativity (6.25) imply that the mock-up satisfies the social aspect of designing an educational tool that will adequately prepare students to meet the demands of their future profession. Additionally, the very high ratings for Workmanship (6.50) and Efficiency (5.88) imply that the mock-up is indeed an effective facility in the cost-efficient transmission of plumbing technology.

The mean score of 6.13 for Safety/Code Compliance can be evaluated as having considerable environmental and political implications. Ensuring that the instructional design strictly complies with the requirements of the Revised Plumbing Code of the Philippines (RPCP) will not only provide students with theoretical knowledge but will enable them to develop environment-friendly practices, including techniques in water conservation and proper waste disposal.

Beyond the mean scoring, the reliability of the expert panel's evaluations was scrutinized using the Intraclass Correlation Coefficient (ICC). From Table 5, it can be observed that the value of 0.203 shows poor agreement. Nevertheless, the variance is understandable due to the differing expertise of the panel members, who come from

different professions, such as engineers and master plumbers, and therefore have varying internal standards when rating. Importantly, the consistency of 0.6708 lies between the moderate level of agreement. This indicates that despite differences in scoring rigor, the experts remained consistent in their relative assessment of the mock-up's attributes, rendering the results statistically acceptable for this pilot validation.

Table 5 *Intraclass Correlation Coefficient (ICC) results for instructional design quality*

ICC Type	Description	Computed Value	Interpretation
ICC(A,k)	Two-way random effects, absolute agreement, average measure	0.203	Poor reliability
ICC(C,k)	Two-way mixed effects, consistency, average measure	0.6708	Moderate reliability
ICC(A,1)	Two-way random effects, absolute agreement, single measure	0.1011	Poor reliability
ICC(C,1)	Two-way mixed effects, consistency, single measure	0.203	Poor reliability

5.5 Acceptance of the Residential Plumbing Mock-Up by Users

The user acceptability phase of this study was undertaken as a pilot study to evaluate the functionality and ergonomic nature of the prototype from a learning viewpoint before a classroom implementation. Following guidelines of Usability Engineering, this pilot study and analysis were undertaken to try and find out important improvements and ensure that students' needs of the hardware interface have been met to their satisfaction. The ratings are shown in Table 6.

Table 6 *Acceptability of residential plumbing mock-up by users*

Category	M	SD	Level of Acceptability
Design	4.83	0.50	Very Good
Workmanship	4.72	0.48	Very Good
Functionality	4.58	0.47	Very Good
User Friendly	4.47	0.44	Good
Safety	4.42	0.47	Good

The ratings attained in this phase were good (for User Friendliness and Safety) provide a strong empirical basis for a broader implementation in the future. These scores place the mock-up as an interesting tool that inspires an optimistic view of the plumbing trade—a consideration which has repeatedly been connected with greater student satisfaction and motivation. Moving beyond the realm of engagement, the tool is very inclusive in design. The high safety score ensures an instrument free from risk, underscoring the very important association between professional plumbing practices and proper sanitation.

High-level ratings in Design (4.83), Workmanship (4.72), and Functionality (4.58) not only prove that the hardware interface is aligned with the learners' intellectual and psychomotor abilities, but by reducing the technological gap, the mock-up interface also allows the learners to tap into the pedagogical potential offered by the device. It functions as a technical training simulation model and keep the technology up-to-date with current industry requirements.

The level of user acceptance among students is an indication that the proposed "greener" method of training is sustainable. Through the use of the functional model, the institution is conserving material resources that otherwise get wasted during the conventional method of plumbing training. Furthermore, the concept of proper plumbing promotes water conservation, an element that is supportive of green learning practices.

Finally, the high acceptance rate is very ideal and that it is among the pieces of critical evidence needed in the acceptance by policymakers for the inclusion of the mock-up. The tool, by fulfilling all rigid set criteria of acceptance by key stakeholders, makes funding and acceptance as a training tool become easier considering the political agenda aimed at enhancing technical education quality in the country.

5.6 Limitations and Future Research

Despite the fact that the study presents a thorough validation of the mock-up, some weaknesses should be noted. First, the quantitative part of the study involved a census of all students (N=9) and experts (N=8) who were present during the time of the study. While the sample includes all available members of Civil and Construction students, it is important to acknowledge that it is relatively small and that the results may have limited generalization power due to lack of external validity. Second, as the study is based on the first three stages of ADDIE (Analysis, Design, Development), it can only address issues related to the validation and acceptance of the mock-up. As such, the mock-up proves to be an effective tool, but no evidence is provided regarding learning outcomes.

To address these gaps, future research needs to concentrate on the Implementation and Evaluation stages of the ADDIE model via a quasi-experimental study design to include a Comparative Study to assess student achievement via pre-test and post-test scores to gauge the effectiveness of the mock-up in developing competencies, Multiple Location Validity conducted in several technical training institutions or among several students groups to improve statistical validity and Field Validation to study the job performance of graduates to see how well the mock-up prepared the participants for the practical plumbing tasks.

These changes will be critical to determining the contribution of the mock-up to the policy at the institutional level and curriculum standards nationally.

6. Conclusion

The study was successful in closing the theory-practice gaps in plumbing education in terms of what the industry demands by creating a residential plumbing mock-up. The research used ADDIE in ensuring that the prototype was more than just a building project; it was a scientifically designed teaching solution. The high content validity index (.95) and Instructional Design Quality Score of 6.19/7.0 are empirical indications that the design was very much in line with the strict guidelines of the Revised Plumbing Code of Philippines.

Furthermore, the integration of STEEP analysis further reinforced the importance of this mock-up in an extended context of environmental sustainability and cost-effectiveness in the context of TVET. Though the experiment could only rely on a small sample in the initial stages of the pilot study, the dominant Very Good response in terms of acceptability clearly points to the efficacy of this mock-up in overcoming the widespread issues of resource scarcity and disengagement of students. Thus, in conclusion, this study serves as an important model in the enhancement of vocational education in order to develop an environmentally compliant workforce that is technologically competent and legally bound.

7. Implications and Recommendations

7.1 Pedagogical and Societal Implications

The “Very Good” level of user acceptability (M = 4.83/5.0) strongly supports the revitalization of student engagement offered by the mock-up design. By moving from “imagined” plumbing systems to real-world manipulation of tangible matter, this mock-up provides more effective means of removing the “Resource Scarcity” issue mentioned within the qualitative analysis phase of the project. As such, the classroom setting shifts from a strictly passive school setting into a dynamic, experiential learning zone as defined by Kolb (1984). In the long run, this could lower student drop-off rates during vocation-based school programs and provide employers with a highly motivated and prepared workforce.

7.2 Technological and Environmental Implications

The high content validity (S-CVI = 0.94) ensures that plumbing students not only gain this skill set but instead gain the knowledge of what constitutes the latest industrial trends as well. As such, this mock-up becomes a means of “green” technology dissemination; through means of leak detection and optimal piping integration, this mock-up method instills a water conservation mentality and mindset of waste reduction among households. In this respect, this mock-up becomes a tool not only for education but a tool of environmental activism as it aligns with available United Nations’ Sustainable Development Goals (SD-Goals 4 and 6). In this respect, this mock-up becomes much more than just a tool of learning; instead, this mock-up becomes a tool of learning with a much higher purpose or goal applied here.

7.3 Economic and Political Implications

The poor absolute agreement (ICC(A,k) = 0.2030) compared with moderate consistency of results (ICC(C,k) = 0.6708) not only shows this mock-up as having experts not scoring appropriately toward a knowledge benchmark

but instead as having a consensus among said experts toward the high rating offered within the mock-up design construction. As a political tool offered distinctly for school-based administration officials, this suggests a sound political mandate toward the establishment of school-based project toward the construction of these mock-ups.

7.4 Recommendations

Full integration into curriculum and repeat application of this development process or methodology for other technical disciplines is recommended for addressing deficit requirements into designing and developing comprehensive and implementation-friendly instructional materials.
Furthermore, to overcome both the limitation of the existing small sample size and low absolute agreement between experts (ICC(A,k) = 0.2030), future studies should include massive validation with multiple industry participants and students.

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Conflict of Interest

Author declares that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The author confirms sole responsibility for the following: study conception, design and construction, data collection, analysis and interpretation of results, and manuscript preparation.

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