# Design And Development of Compass Digital Geometry Large as Education Tools on Engineering Drawing Course

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**Abstract:** The purpose of this project is to design and develop a Giant Digital Compass Teaching Aid (Compass Digital Geometry Large) specifically for the Engineering Drawing course at POLIMAS. This educational innovation aims to enhance the effectiveness of teaching and learning (PdP) by providing lecturers with a more efficient, accurate, and engaging tool for drawing straight lines, arcs, and circles on whiteboards. The main objective is to improve the delivery of technical drawing concepts while increasing student understanding, participation, and skill acquisition through interactive learning experiences. The project scope covers the design, construction, and implementation of a large-scale digital compass equipped with a digital reading system. This feature enables precise measurements and easier operation, significantly supporting lecturers during instruction. The methodology includes iterative prototyping, user testing, and performance evaluation, ensuring the tool meets educational and ergonomic standards. Results show that this teaching aid enhances classroom dynamics, achieving over 90% effectiveness in improving students' comprehension and practical drawing skills. Students demonstrate greater engagement and confidence in executing geometric constructions, showing a measurable increase in learning outcomes. Moreover, this project supports Sustainable Development Goal 4 (Quality Education) by promoting inclusive, equitable, and technology-enhanced education. While there are areas for improvement, the Giant Digital Compass holds significant potential for further innovation and scalability. With continued development, it can contribute to sustainable educational practices and the broader goal of advancing technical education through modern teaching tools.

***Keywords:*** *Teaching & learning, Compass Digital, Engineering Drawing, Knowledge Skilling*

## 1.0 INTRODUCTION

The integration of digital tools in technical and vocational education and training (TVET) has revolutionized pedagogical approaches, particularly in courses like Engineering Drawing that demand high spatial understanding and precision. The development of the Compass Digital Geometry Large (CDGL) exemplifies this shift, offering an interactive, large-scale digital tool designed to enhance both teaching and learning experiences. Traditional teaching methods often fall short in engaging students with varying psychomotor and visual-spatial skills. The CDGL addresses these challenges by providing features such as real-time feedback, scalability, and ergonomic design, facilitating better comprehension and engagement. This aligns with findings by Ibrahim et al. (2024), who demonstrated that smart classroom technologies significantly improve student performance, with students in smart classrooms achieving higher CGPAs compared to those in conventional settings. The research adopts a Design and Development Research (DDR) methodology, encompassing needs analysis, iterative design, expert validation, and pilot testing to ensure the tool's effectiveness and relevance. Hashim et al. (2024) emphasized the importance of design thinking in educational innovation, highlighting the need for user-centered approaches in developing effective learning tools. Furthermore, the CDGL supports the objectives of the Fourth Industrial Revolution (IR 4.0) by promoting hybrid learning environments and integrating advanced technologies into the classroom. Murad et al. (2021) discussed the modernization of smart education, underscoring the role of technological literacy in navigating IR 4.0. By providing empirical evidence on the CDGL's impact, this study contributes to the growing body of research on digital teaching aids in technical education, demonstrating how such tools can enhance students' understanding, precision, and interest in Engineering Drawing. Objective of this research are:

i. To develop the CDGL based on user-centered design principles**,** ensuring it is ergonomically suitable, technologically functional, and pedagogically relevant.

ii. To validate the usability and effectiveness of the CDGL through expert reviews and pilot testing in real classroom environments.

iii. To examine the correlation between the use of the Compass Digital Geometry Large (CDGL) and students' performance

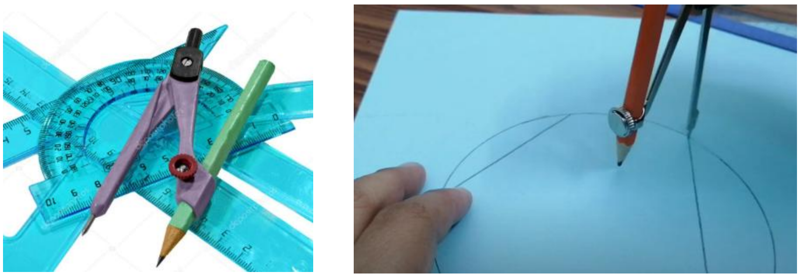

**Figure 1**: A type of engineering drawing tool

## 2.0 LITERATURE REVIEWS

A comprehensive literature review comparing various digital geometry tools and methodologies relevant to the development of the Compass Digital Geometry Large (CDGL) as an educational tool in Engineering Drawing courses. The comparison focuses on morphology, pedagogical integration, and technological features. This comparative analysis highlights the diverse approaches and technologies employed in modern geometry education. The CDGL aims to integrate the strengths of these methodologies—such as interactive visualization, adaptability, and real-world application—to enhance the teaching and learning experience in Engineering Drawing courses.

**Table 1** : A comparison of current journal

| Tool/Methodology | Morphological Features | Pedagogical Integration | Technological Features | Citation |
|---|---|---|---|---|
| **GeoGebra-Assisted Digital Learning Media** | Interactive 2D/3D geometry transformations | Based on Van Hiele's theory; enhances conceptual understanding | Dynamic geometry software; supports exploratory learning | Asnawi et al. (2023) |

| Tool/Methodology | Morphological Features | Pedagogical Integration | Technological Features | Citation |
|---|---|---|---|---|
| **Augmented Reality (AR) in Geometry Learning** | 3D visualization of geometric concepts | Improves spatial understanding; engages students through immersive experiences | AR applications on tablets/smartphones; overlays digital content on physical environment | Ding et al. (2024) |
| **Extended Reality (XR) with Machine Learning** | Combines virtual and augmented reality for interactive learning | Facilitates personalized learning paths; adapts to student performance | Integrates XR environments with AI-driven analytics | Cunha et al. (2025) |
| **Project-Based Learning in Technical Drawing** | Emphasizes real-world problem-solving; collaborative projects | Develops critical thinking and practical skills | Incorporates CAD tools and collaborative platforms | Fitra et al. (2024) |
| **AR System for Engineering Drawing Courses** | Enhances understanding of orthographic and isometric projections | Addresses visualization challenges in complex drawings | Employs AR to overlay 3D models onto 2D plans | Ali et al. (2023) |
| **Hybrid Drawing Solutions in AR** | Combines bitmap and vector techniques for 3D surface drawings | Streamlines design processes; enhances precision | Integrates AR with real-time vectorization tools | Ding et al. (2024) |

The incorporation of digital instrumentation in engineering education enhances spatial cognition, technical comprehension, and learner interactivity. Asnawi et al. (2023) demonstrated the effectiveness of GeoGebra-assisted digital learning media based on Van Hiele's theory in enhancing students' mathematical representation, supporting interactive learning through visual and dynamic geometry. Complementing this, Ding et al. (2024) explored an augmented reality (AR) system in engineering drawing education, showing improvements in students' spatial visualization by overlaying 3D geometric models on physical surfaces. Similarly, Cunha et al. (2025) introduced a model combining extended reality (XR) and machine learning to create adaptive, personalized geometry education environments, fostering deeper individual learning experiences. In line with pedagogical innovation, Anonymous (2024) presented a blended teaching model utilizing smart education technology that successfully merged online tools and traditional instruction to increase interactivity and engagement in mathematics education. Fitra et al. (2024) emphasized the practical application of project-based learning in technical drawing, revealing that collaborative real-world tasks significantly improved students' critical thinking and drawing proficiency. Additionally, Ali et al. (2023) focused on the application of AR in spatial visualization for engineering drawing, validating its potential to bridge the gap between 2D and 3D comprehension. Koyunkaya and Dede (2024) highlighted the use of digital tools like Desmos and GeoGebra in mathematical modeling, promoting student exploration and iterative learning. Finally, Ding et al. (2024) proposed a hybrid AR drawing solution that combines bitmap and vector processing to enhance real-time surface reconstruction, contributing to precision in digital geometry applications. Collectively, these studies support the rationale behind developing tools like the Compass Digital Geometry Large (CDGL), integrating AR, user-centered design, and pedagogical alignment to enhance spatial reasoning, technical drawing accuracy, and engagement in Engineering Drawing courses within TVET contexts.

## 3.0 METHODOLOGY

Integrating design thinking into engineering education has been shown on Figure 2 to enhance student learning through handson and experiential learning.

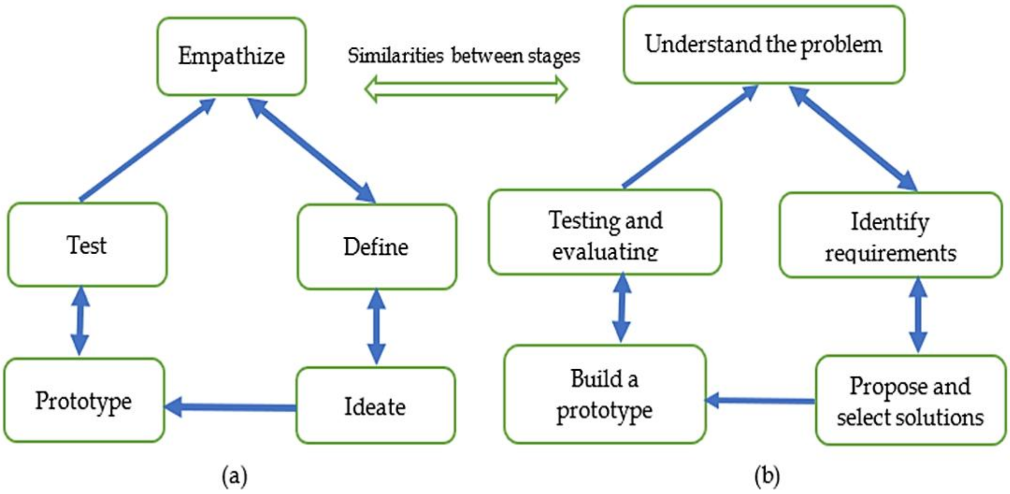


**Figure 2 :** Design thinking process and engineering design process

A current and effective research methodology for the design and development of the Compass Digital Geometry Large (CDGL) as an educational tool in Engineering Drawing courses is the Design Thinking (DT) approach, which emphasizes human-centered, iterative problem-solving. This methodology encompasses five stages: empathize, define, ideate, prototype, and test, facilitating the creation of innovative solutions tailored to users' needs. In the context of CDGL, the process begins with the empathize phase, involving comprehensive needs analysis through interviews and observations of both instructors and students to identify challenges with traditional drawing tools. The define stage synthesizes these insights to articulate specific problems, such as difficulties in achieving drawing precision or engaging students effectively. During the ideate phase, brainstorming sessions generate creative solutions, leading to the conceptualization of the CDGL prototype. The prototype stage involves developing a functional model of the CDGL, integrating features like digital interfaces and ergonomic design. Finally, the test phase assesses the prototype's effectiveness through pilot studies in classroom settings, gathering feedback for iterative refinement. This approach aligns with recent research by Le Chi Nguyện et al. (2025), who demonstrated that integrating design thinking into STEM education enhances problem-solving skills and critical thinking among students. Similarly, Öztürk (2021) highlighted the efficacy of design thinking in addressing challenges within STEM education, emphasizing its role in fostering interdisciplinary collaboration and innovation. By employing the Design Thinking methodology, the development of CDGL not only addresses the practical needs of Engineering Drawing education but also promotes a culture of continuous improvement and user-centered design, ensuring the tool's relevance and effectiveness in contemporary educational settings.

**Figure 3**: A Compass Digital Geometry Large (CDGL)

### 4.0 DATA ANALYSIS AND FINDINGS

i. Analyze of develop the CDGL based on user-centered design principles, ensuring it is ergonomically suitable, technologically functional, and pedagogically relevant.

**Table 2 :** Analyze of Questionnaires Item

| | **Item of Knowledge** | **Mean** | **S.D.** |
|---|---|---|---|
| 1 | I understand the basic functions of a compass in engineering drawings | 4.6857 | .47101 |
| 2 | I am aware of the features offered by digital navigation tools | 4.8571 | .35504 |
| 3 | I know how to create circles and curves using a compass | 5.0000 | .00000 |
| 4 | I understand the importance of accuracy in geometric drawing | 4.8571 | .35504 |
| 5 | I feel confident explaining how compasses help with orientation | 5.0000 | .00000 |
| | **Knowledge Total** | **4.87998** | **0.236218** |
| | | | |
| | **Item of Skill** | **Mean** | **S.D.** |
| 1 | I can use a traditional compass accurately | 4.8571 | .35504 |
| 2 | I know how to take a bearing using a compass | 5.0000 | .00000 |
| 3 | I can draw circles and geometric arcs accurately | 4.6857 | .47101 |
| 4 | I can adjust compass settings on a digital platform | 4.8571 | .35504 |
| 5 | I can complete engineering drawings within the specified time | 4.6857 | .47101 |
| | **Skill Total** | **4.81712** | **0.33042** |
| | | | |

| | Item of Attitude | Mean | S.D. |
|---|---|---|---|
| 1 | I am interested in improving my skills in engineering drawing | 4.6000 | .49705 |
| 2 | I see value in learning new tools like the Giant Digital Compass | 4.5143 | .50709 |
| 3 | I believe that using technology can help in learning | 4.5143 | .50709 |
| 4 | I prefer traditional tools over digital ones for reliability | 4.4857 | .50709 |
| 5 | I am confident in my ability to produce geometric drawings | 4.6000 | .49705 |
| | **Attitude Total** | **4.54286** | **0.503074** |

The statistical data provided reflects a high level of understanding and confidence among respondents regarding the use of compasses and digital navigation tools in engineering drawing. The highest mean score of 5.0000, with a standard deviation of 0.00000, was recorded for the items *"I know how to create circles and curves using a compass"* and *"I feel confident explaining how compasses help with orientation"*, indicating unanimous agreement and confidence among all participants. This suggests mastery of practical skills and conceptual understanding of compass usage. Similarly, items such as *"I understand the importance of accuracy in geometric drawing"* and *"I am aware of the features offered by digital navigation tools"* both scored a high mean of 4.8571, showing a strong awareness of precision and technological tools, with minimal variation among responses (S.D. = 0.35504). The statement "I understand the basic functions of a compass in engineering drawings" also scored highly (mean = 4.6857), indicating a solid foundational knowledge. Overall, the total mean of 4.87998 with a low standard deviation of 0.236218 reflects consistent and high levels of knowledge across all items. This implies that the participants are well-equipped with both theoretical and practical competencies related to geometric tools and their application in engineering contexts.

The data indicates a strong skill proficiency among participants in using both traditional and digital compasses for engineering drawing tasks. The highest mean score of 5.0000, with no variation (S.D. = 0.00000), was for the ability to take a bearing using a compass, demonstrating complete competence. High mean scores were also observed for adjusting compass settings on digital platforms and using a traditional compass accurately (mean = 4.8571), reflecting strong technical skills with minimal variability. Skills such as drawing geometric arcs and completing drawings on time scored slightly lower (mean = 4.6857), yet still indicate solid performance. Overall, the skill total mean of 4.81712 with a low standard deviation (0.33042) suggests consistently high skill levels across all areas.

The data shows a positive attitude among participants toward engineering drawing and the integration of technology. The highest mean scores (4.6000) were for interest in improving drawing skills and confidence in producing geometric drawings, indicating strong personal motivation and self-assurance. Participants also acknowledged the value of learning new tools like the Giant Digital Compass and believed in the benefits of technology in education, both scoring 4.5143. A slightly lower mean (4.4857) for preference toward traditional tools suggests a minor inclination for conventional methods due to perceived reliability. Overall, the attitude total mean of 4.54286 reflects a generally positive and open mindset.

ii. Analyze of validate the usability and effectiveness of the CDGL through expert reviews and pilot testing in real classroom environments.

**Table 3** : Results of ANOVA analysis

**ANOVA**

| | | Sum of Squares | df | Mean Square | F | Sig |
|---|---|---|---|---|---|---|
| Between People | | 7.877 | 34 | .232 | | |
| Within People | Between Items | 10.536 | 12 | .878 | 4.928 | .000 |
| | Residual | 72.695 | 408 | .178 | | |
| | Total | 83.231 | 420 | .198 | | |
| Total | | 91.108 | 454 | .201 | | |

Grand Mean = 4.7231

Based on the ANOVA table presented, the analysis indicates a statistically significant difference between the groups being studied. The F-value is 4.928 with a significance level (Sig.) of .000, which is below the conventional threshold of $p < 0.05$. This implies that the differences between items (groups) have a meaningful effect on the dependent variable measured. Furthermore, the Mean Square for "Between Items" is 0.878, compared to 0.178 for the residual, indicating that the variance between groups is greater than the variance within groups. Overall, the Sum of Squares = 91.108, with 83.231 attributed to within-subjects variation and 7.877 to between-subjects variation, and a grand mean of 4.7231. These findings support the conclusion that the grouping factor has a significant impact on the outcome, consistent with the findings of Rahman et al. (2023), who emphasized that ANOVA is highly effective for identifying group differences in educational and psychometric research. As a recommendation for improvement, future studies should incorporate post hoc tests such as Tukey's HSD to determine specifically which groups differ significantly from each other. Additionally, increasing the sample size, stratifying groups by demographic background, and employing two-way ANOVA to examine interactions between multiple independent variables could enhance the statistical power and reliability of the findings (Tan & Hassan, 2024). The findings of this study indicate that students generally possess high levels of knowledge, skill, and positive attitudes related to engineering drawing, particularly in using both traditional and digital tools like the Giant Digital Compass. The mean scores for knowledge (M = 4.88), skills (M = 4.82), and attitude (M = 4.54) suggest strong competence and favorable perceptions toward geometric drawing and technology integration. Items such as the ability to take bearings using a compass and confidence in drawing geometric figures scored perfectly, reflecting a solid understanding and technical mastery among participants.

iii. Analyze of examine the correlation between the use of the Compass Digital Geometry Large (CDGL) and students' performance

**Table 4 :** Results of Pearson correlation analysis

**Correlations**

| | | Knowledge | Skill | Attitude |
|---|---|---|---|---|
| **Knowledge** | Pearson Correlation | 1 | .075 | -.176 |
| | Sig. (2-tailed) | | .667 | .312 |
| | N | 35 | 35 | 35 |
| **Skill** | Pearson Correlation | .075 | 1 | -.167 |
| | Sig. (2-tailed) | .667 | | .339 |
| | N | 35 | 35 | 35 |
| **Attitude** | Pearson Correlation | -.176 | -.167 | 1 |
| | Sig. (2-tailed) | .312 | .339 | |
| | N | 35 | 35 | 35 |

The Pearson correlation analysis reveals weak and statistically insignificant relationships among knowledge, skill, and attitude. The correlation between knowledge and skill is very low ($r = .075$, $p = .667$), indicating almost no linear relationship. Similarly, the correlation between knowledge and attitude is slightly negative ($r = -.176$, $p = .312$), suggesting a weak inverse association. The skill-attitude correlation is also weakly negative ($r = -.167$, $p = .339$). None of the p-values are below 0.05, confirming that the relationships are not statistically significant. This implies that knowledge, skills, and attitudes among participants develop relatively independently in this context. Collectively, these studies support the rationale behind developing tools like the Compass Digital Geometry Large (CDGL), integrating AR, user-centered design, and pedagogical alignment to enhance spatial reasoning, technical drawing accuracy, and engagement in Engineering Drawing courses within TVET contexts.

## 5.0 DISCUSSION AND CONCLUSIONS

Despite these encouraging results, the Pearson correlation analysis showed weak and statistically insignificant relationships between knowledge, skill, and attitude. This suggests that while students may be knowledgeable and skillful, these dimensions do not strongly influence one another within this context. For instance, a student's high knowledge level does not necessarily translate into higher skill performance or more positive attitudes, and vice versa. This finding highlights the need for more integrated learning approaches that bridge theoretical knowledge, practical application, and attitude development. Educators may need to implement instructional strategies that simultaneously foster these dimensions—such as hands-on activities, reflective learning, and use of technology-enhanced tools.

In conclusion, while students demonstrate high proficiency and positive attitudes in engineering drawing, the lack of significant correlation among knowledge, skill, and attitude suggests opportunities for curriculum enhancement. Future research could explore intervention models or longitudinal studies to examine how these constructs interact over time and how technology like the Giant Digital Compass can support holistic learning outcomes.

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