
PERFORMANCE ANALYSIS IN CAD TO UPDATE THE DESIGN SUBJECT, WITH ALIGNMENT TO COMPETENCY STANDARDS

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Abstract-- Updating the academic program based on CAD competency standards optimizes practical training, aligning academia with labor demands. The results validated the need to structure courses under professional certifications, ensuring that students acquire relevant technical skills. (Florida, 2024). The study demonstrated that an experimental approach to design education, supported by industry-validated tools, can reduce training disciplines to enhance technological and business development. This study analyzed the level of performance in CAD tools (SolidWorks and AutoCAD 2D) among industrial engineering students and proposed as an improvement the updating of the current academic program through the integration of the industrial design subject developed through the fusion and alignment with the competency standards of the (CSWA in SolidWorks and Basic 2D AutoCAD) (SOLIDWORKS, 2025), required in the labor market.

This research is applied, explanatory, and quantitative in nature, with a cross-sectional experimental approach and a hypothetical-deductive method. A sample of 100 students was evaluated using pre-intervention academic results, comparing their performance before and after updating the program with certifications. Statistical tests (significance level 0.05) were applied to measure differences in the mean (255 vs. 286.5) and calculate confidence intervals.

Previously, students showed low proficiency (average: 30.5/335). After the update, the post-intervention mean was 286.5, with a 95% confidence interval (281.29–291.71), showing a 97% improvement in efficiency. The significant difference ($p < 0.05$) confirmed that the integration of certifications increased performance, ensuring basic competencies required in the industry.

Keywords-- CAD, Alignment, Competency standard.

Abstract-- The update of the academic program based on CAD competency standards optimized practical training, aligning academia with labor demands. The results validated the need to structure subjects under professional certifications, ensuring that students acquired relevant technical skills. (Florida, 2024). The study demonstrated that an experimental approach to teaching industrial design, supported by tools validated in the industry, is key to reducing training gaps and enhancing technological-business development. This study analyzed the level of performance in CAD tools (SolidWorks and AutoCAD 2D) among industrial engineering students, and proposed an update as an improvement of the current academic program through the integration of the industrial design subject developed by merging and aligning with the competency standards of the required certifications (CSWA in SolidWorks and Basic 2D AutoCAD). (SOLIDWORKS, 2025). Required in the labor market. This research was applied, explanatory, and quantitative in nature, with a cross-sectional experimental approach and a hypothetical-deductive method. A sample of 100 students was evaluated through pre-intervention academic results, comparing their performance before and after updating the program with certifications. Statistical tests were applied (significance level 0.05) to measure differences in the mean (255 vs. 286.5) and to calculate confidence intervals. Previously, students showed low mastery (average: 30.5/335). After the update, the post-intervention mean was 286.5, with a 95% confidence interval (281.29–291.71), demonstrating a 97% improvement in efficiency. The significant difference ($p < 0.05$) confirmed that the integration of certifications increased performance, ensuring the basic competencies required in the industry.

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INTRODUCTION

Design engineering, as a core discipline in industrial engineering, integrates technical and creative principles to drive innovation in product development and process optimization, responding to the demands of an increasingly digitized global market. In this scenario, mastery of CAD (Computer-Aided Design) tools (Autodesk, 2025), such as SolidWorks (Corporation, www.solidworks.com, 2002-2025) and AutoCAD (Autodesk, 2025), emerges as a critical competency to ensure the employability and adaptability of professionals. However, the analysis reveals a persistent gap between academic programs and the practical demands

of the industrial sector, particularly in the training of technical skills validated by international standards. This analysis highlighted that, although universities incorporate industrial design subjects, the lack of updating in teaching methodologies and the poor integration of professional certifications (such as CSWA or AutoCAD 2D) (Corporation, CSWA Certification Guide, 2022) limit students' ability to operate these tools effectively. This disconnect not only compromised the employability of graduates, but also hindered the ability of companies to innovate, as they depended on professionals with skills that were misaligned with current technological needs. Similarly, there is a gap between what is established as should be taught to students and what is actually taught to them.

While the importance of modernizing engineering curricula has been recognized in theory, questions remain about how to measure and improve student performance in CAD environments. For example, there are no robust quantitative studies evaluating the impact of integrating professional certifications into academic performance, nor has there been systematic exploration of how structured methodologies, such as certifications in these CAD systems that were incorporated into the current educational program, improved students' level of knowledge. To this end, the PDCA (Plan- - Check-Act) cycle (Moen, 2010) was implemented, as it can be applied as a methodological framework for diagnosing and optimizing educational processes. The PDCA, which originated in the field of industrial quality control, is an iterative approach consisting of four phases: Plan (define objectives and strategies), Do (implement actions), Check (evaluate results), and Act (adjust processes based on evidence). Its usefulness lies in its ability to systematize continuous improvement through feedback cycles, making it an ideal tool for studies that seek to diagnose problems and validate interventions in educational contexts.

Furthermore, the relationship between the adoption of labor standards in academia and the acquisition of basic skills required in industrial projects is unknown, making it difficult to prioritize evidence-based curriculum strategies.

The objective of this research is to analyze the level of performance in computer-aided design tools among industrial engineering students, using the Deming cycle as a methodological framework to structure the study in four stages: 1) Planning: initial performance in these software programs was diagnosed through standardized assessments; 2) Execution: A pedagogical intervention based on the integration of professional certifications (CSWA and AutoCAD 2D) was implemented. (SOLIDWORKS, 2025). 3) Verification: The impact was measured quantitatively using

statistical analysis (t-tests, 95% confidence intervals); and 4) Action: Curriculum adjustments were proposed based on the results. To this end, two theoretical propositions were tested: 1) The inclusion of industry-validated certifications significantly increases students' technical proficiency in computer-aided design, and 2) The application of the Plan-Do-Check-Act system as a research methodology allows for the systematic identification and correction of training gaps, optimizing the effectiveness of pedagogical interventions.

The relevance of this study lies in its dual approach: it addressed an urgent issue in technical training and demonstrated how management methodologies traditionally applied in industry can be adapted as educational research tools. The theoretical implications included the validation of PDCA as a model applicable to academic studies, extending its use beyond industrial contexts, and the generation of empirical evidence on the effectiveness of certifications as a bridge between academia and the productive sector. By focusing on the objective measurement of competencies and methodological iteration, this work not only contributed to the discussion on curricular innovation, but also set a precedent for future research seeking to integrate management tools into educational assessment.

In short, this research went beyond merely identifying training deficiencies: it proposed a replicable model that combines rigorous diagnosis, standards-based intervention, and continuous assessment, positioning itself as a benchmark for institutions seeking to align their academic offerings with the technological challenges of the 21st century.

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DEVELOPMENT

Applied Research. This type of research seeks to solve practical problems or improve existing processes by applying theoretical knowledge in real contexts. Its focus is on immediate usefulness and the generation of concrete solutions. (Bailey, 1994) **Explanatory Research.** Identifies cause/relationship between variables, solving the "why" of phenomena. Deepens understanding of mechanisms by testing hypotheses. (Hernández Sampieri, 2014). **Quantitative Approach.** Based on the collection and analysis of numerical data to generalize results. Uses statistical methods and structured measurements, prioritizing objectivity and replicability. (Creswell, 2018) **Experimental Design.** Involves the intentional manipulation of one or more independent variables to observe their effect on dependent variables under controlled conditions. It includes control and experimental groups. (Campbell, 1963) **Hypothetical-Deductive Method.** It starts from the formulation of hypotheses based on observations, followed by logical deductions that are empirically tested.

It is central to the validation of scientific theories. (Popper, 1959) Cross-sectional approach. It collects data at a single point in time to analyze variables in a specific population. It is efficient for descriptive or associative studies, although it does not evaluate long-term changes. (León, 2003)

The research carried out covers multiple dimensions and approaches, reflecting a comprehensive and rigorous approach to understanding and addressing the problem under study. As applied research, it focused on finding practical and concrete solutions to specific challenges in the field of interest. This research deepens the understanding of the causes and/or consequences of the phenomenon under analysis, allowing for the identification of patterns and significant relationships. In addition, by using quantitative methodology, it sought to analyze and quantify data objectively, providing a solid basis for informed decision-making.

A controlled experiment was carried out, and the research followed a hypothetical-deductive approach, which involved formulating hypotheses based on previous observations and subsequently validating them through logic and empirical evidence. Likewise, a cross-sectional design was adopted, which allowed for the comparison of characteristics or situations at different times and in different contexts, providing a broader and more complete view of the phenomenon studied.

Profile, selection, and delimitation of the population and/or participants

Within a diverse group of industrial engineering students ($N = 440$), a stratified proportional sample ($n = 100$) was selected to ensure representativeness across semesters (3, 5, 7, 9). According to Cochran's method (1977), 27, 25, 23, and 25 subjects were assigned to each category, maintaining population ratios and reducing bias, thus ensuring accurate conclusions and a uniformly distributed sample that reflects the structure of the study group.

Stratified Sample Calculation Initial data:

- Total population (N): 440 students.
- Desired sample size (n): 100 students.
- Strata (semesters): 3rd, 5th, 7th, and 9th.

Population of each subgroup:

Table 2. *Population by subgroup.*

Semester	Population
3	120 students
5	110 students
7	100 students
9	110 students
Total	440 students

Source: Own elaboration.

Calculate the sample by stratum (proportional)

The formula for proportional stratified sampling is (Cochran, 1977): $n_i = (N_i/N) \times n$

n

Final result:

Table 3. Population and sample by subgroup.

Semester	Population	Sample
3rd	120	27
5th	110	25
7	100	23
9	110	25
Total:	440	100

Source: Own elaboration.

The instrument was designed based on the standards of the Official Associate Level Certification for Mechanical Parts Design and the basic certification in two-dimensional technical drawing software mentioned above, ensuring that the questions and exercises reflect the technical skills and evaluation criteria established by these certifications.

Alignment with certifications:

SolidWorks theory section (questions 1-14): worth 14 points. Associate Level Certification in Mechanical Parts Design criteria: Basic concepts of 3D modeling (parts, assemblies, drawings).

Use of key tools (extrusion, trim, assembly with "Mate"). Interpretation of the design tree ("FeatureManager Design Tree").

AutoCAD theory section (questions 15-33): worth 18 points.

Basic AutoCAD 2D certification criteria:

Mastery of basic commands (Line, Trim, Offset, Layers).

Creation and management of blocks, dimensioning, and use of coordinates.

Practical section on SolidWorks (exercises 1-8): worth 153 points. CSWA skills:

Parametric modeling of parts with metric precision.

Calculation of physical properties (mass, center of mass).

Creation of assemblies with geometric constraints.

AutoCAD practical section (exercises 1-5): worth 150 points. Basic certification skills:

2D technical drawing based on plans with exact dimensions.

Use of layers, blocks, and efficient editing tools.

Application:

Digital platform: A controlled environment simulating official certification conditions was used (e.g., limited time, access only to valid tools).

Expert validation: CSWA- and AutoCAD-certified instructors reviewed the instrument to ensure its alignment with standards.

Database construction

Variables added for alignment with certifications:

Categorization by skills:

SolidWorks: Modeling of assembled parts and/or technical drawings (90%), theory (10%). (academia, 2025)

AutoCAD: Basic commands, layer management, and dimensioning (90%), theory (10%). (AUTODESK, 2025).

Reference scores:

Pass threshold based on CSWA criteria ($\geq 75\%$ in practice and theory) and AutoCAD ($\geq 75\%$).

Statistical analysis

Focus on certification standards:

Comparison with benchmarks:

Percentage of students reaching the certification threshold pre/post-course. (reddit, 2025).

2. Gap analysis:

Classification of lowest-performing skills (e.g., use of "Mate" in SolidWorks or "Trim" in

AutoCAD). (reddit, 2025).

3. Normality tests (Sample t):

or To determine whether the data follow a normal distribution and select parametric or non-parametric tests.

Software Used (Relevance to Certifications)

SolidWorks 2023: Educational version, used to ensure compatibility with the tools evaluated in CSWA (e.g., "Mass Properties," "Design Tree"). (Minitab, 2024).

AutoCAD 2024: 2D mode configuration, for the simulation of certification processes. (AUTODESK, 2025).
Certification simulators. (Autodesk, 2025).

O For practice purposes, official question banks modified for academic purposes were used. Content validity: The instrument was validated by comparison with sample CSWA and AutoCAD exams provided by Dassault Systèmes and Autodesk.

Reliability: Cronbach's alpha coefficient >0.85 , consistent with psychometric standards for certifications. (Muñiz, 2018).

The results obtained through the methodology described are integrated into a Deming cycle (Plan-Do-Check-Act), an iterative approach to the continuous improvement of the educational process. This allowed for the transformation of quantitative and/or qualitative findings into actions necessary to optimize training in SW and Systems in two dimensions, ensuring alignment with CSWA and 2D Digital Modeling certification standards. Below is a detailed description of how each phase of the Cyclical Feedback Model is linked to the research:

Plan (Plan) Objective: I analyze the performance in Computer-Aided Design of Industrial Engineering students by applying an instrument consisting of 46 theoretical and practical questions with a total value of 335 points, through which information is collected to evaluate the level of theoretical and practical knowledge in 2D and 3D modeling systems with the purpose of studying the impact obtained in the current academic program with the level of performance in 2D and 3D Digital Design computer systems. (IES, 2024). In order to gather information for this analysis, this instrument was applied to a sample of 100 students in their third, fifth, seventh, and ninth semesters, with a population of 440 students in the industrial engineering program at the university level.

Do (Do): The industrial design course was developed with a focus on the aforementioned certifications in 2D and 3D digital design and modeling, consisting of updating the syllabus and a

series of specific objectives ranging from the analysis of curriculum content. This update to the design course was implemented in a sample of 100 students in their third, fifth, seventh, and ninth semesters out of a population of 440 industrial engineering students, who were evaluated beforehand to determine their initial level of performance in CAO. The experiment was conducted over a semester, covering all of the updated topics in the design course.

Check: The results showed that 97% of the students who took the updated design course had the basic CAD performance level required to carry out activities in today's industry. This showed us that, on average, the students obtained

286.5 points out of the 335 points available on the instrument.

And within the (Act) section, it was proposed that this new update to the design subject could be implemented on a large scale at the university level, introducing it in the eighth semester of the industrial engineering degree program. This analysis showed us that, with regard to the proposed update to the design subject, constant monitoring of the academic program for future industrial engineers is necessary.

DISCUSSION AND ANALYSIS OF RESULTS

What is the level of student performance in using CAD programs with the current academic program? and the specific objective "To evaluate the current level of performance using an instrument aligned with SolidWorks CSWA standards and AutoCAD 2D Basic Certification," as we can see in Figure 15, it can be concluded that the mean differs from 255 at a significance level of 0.05. Quantify the uncertainty associated with estimating the mean from the sample data. You can be 95% sure that the true mean is between 24.713 and 36.287. This represents 100% of participants obtaining a score lower than the 255 points required for passing the instrument, which indicates that none of the participants in the experiment have a basic level of knowledge in design engineering.

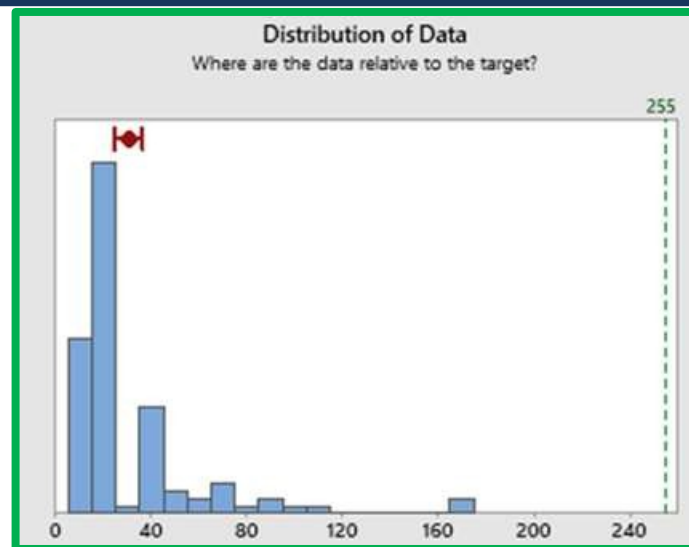


Figure 1. Data distribution. Where is the data related to the objective?

Source: own elaboration.

As mentioned (Metaute Paniagua, Flórez Osorio, Rúgeles Contreras, & Castaño, 2018). Similarly, the importance of students acquiring the practical skills necessary for professional performance is emphasized, which is reflected in the gaps in CAD skills and performance, as mentioned by (Díaz-Schery, 2024) in his publication. This responds to Hypothesis 1, where H_0 is rejected and H_a is accepted since "The knowledge acquired with the academic program is less than the minimum required."

Responding to the second question: Will the implementation of a new academic program aligned with SolidWorks (CSWA) and AutoCAD 2D standards increase student performance levels? and to the specific objectives: "Design a proposal for a merged academic program aligned with CSWA competency standards for SolidWorks and AutoCAD 2D (basic certification) and validate the effectiveness of the proposed academic program through student performance, considering the minimum score of 255 in CSWA standards for SolidWorks and AutoCAD 2D (basic certification).

As can be seen in Figure 16, it can be concluded that the mean differs from 255 at a significance level of 0.05. This quantifies the uncertainty associated with the estimate of the mean of 286.5, based on the 100 data points. A 95% confidence level was obtained for the true mean to be between 281.29 and 291.71 points. This represents 97% of participants obtaining a result equal to or greater than the 255 points required for approval of the instrument, which indicated that only 3% of the sample had

lower values.

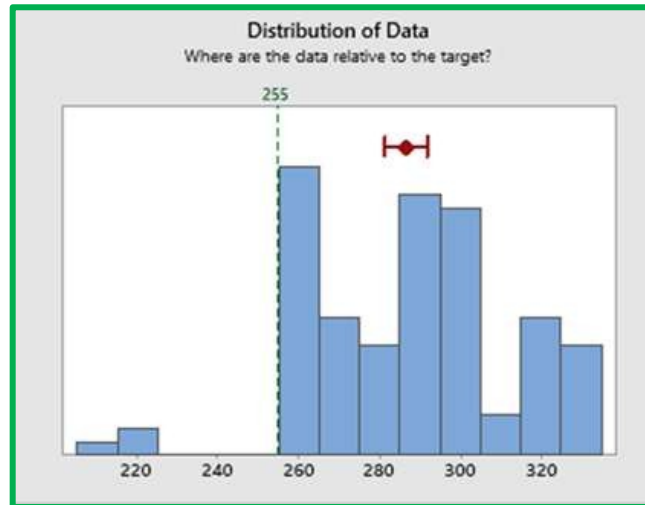


Figure 2. Data distribution. Where is the data related to the objective?

Source: own elaboration.

The sample succeeded in differentiating the mean and/or the target. (Minitab, 2024). The three data points obtained in Table 5 with IDs: 9, 74, and 100 (unusual in comparison with the others due to reasons such as participant absenteeism and poor monitoring of activities), although they did not validate the instrument, showed a significant increase compared to the initial results. This gives us a difference of more than 90% with a mean value of 12.01, thus obtaining 97% of participants who obtained equal to or greater than the 255 points required to validate the instrument.

As shown in Figure 17, in the results obtained before the course was taught, 100% of the students who took the test did not pass it, while after the course was taught, the results show that 97% of the students passed with a score higher than the required score.



Figure 3. Comparison of the number of students accredited before and after the course.

Source: Own elaboration.

Cohen's index:

$$d = \frac{M_2 - M_1}{S}$$

Fig. (2)

Table 3. *Cohen's Standard Criteria.*

According to Cohen's standard criteria:	
0.2 - 0.5 →	Small
0.5 - 0.8 →	Moderate
0.8 - 1.2 →	Large
> 2.0 →	Very large
> 4.0 →	Extremely large

A value of 9.23 is unusually high and suggests that the difference between the initial and final results is very significant. This indicates that the instrument used had a massive impact on the sample analyzed.

The purpose of the above analysis is to evaluate the impact of the proposed academic program update through the calculation of Cohen's index (d), following the criteria of (Cohen, 1988). To do this, the results obtained at two points in time are compared: before and after the application of the instrument.

Descriptive statistics for both measurements were presented, including the mean, 95% confidence interval, and standard deviation. Subsequently, Cohen's index was indicated for the purpose of determining the effect and/or evaluating the change in experimentation.

The results obtained allowed us to establish the effectiveness of the instrument in relation to the proposed objective.

The results of this study validated and expanded previous theoretical approaches on the need to align academic training with competency standards. In line with (Metaute Paniagua, Flórez Osorio, Rúgeles Contreras, & Castaño, 2018), who emphasizes the development of critical thinking and innovation, the integration of CAD certifications was shown to not only improve technical skills but also foster metacognitive competencies, such as structured problem solving

(post-intervention mean: 286.5 vs. initial mean: 30.5). This contrasts with studies such as those by (Naranjo-Pizano, 2019), which historically prioritized theoretical foundations over practical applications, showing that an exclusively theoretical approach to CAD generates performance gaps (example: 87% of students with errors in 3D modeling pre-intervention).

The effectiveness of the PDCA cycle as a methodological framework supports its adaptability to educational contexts, as Moen (2010) proposed in quality management. This approach made it possible to identify and/or correct pedagogical deficiencies in the system, such as the theoretical/practical disconnect in AutoCAD (98% of initial errors), validating its usefulness for continuously optimizing training processes. This is where traditional models such as outcomes-based education (OBE) differ, as they concentrate feedback through standard estimates, which provide solutions not explored in previous work (Crespo, 2019). This generated contributions to the field such as: Empirical validation of certifications as a bridge between academia and industry: The results refuted criticisms about the superficiality of certifications (Rodríguez Mesa, 2021), demonstrating that their integration into the curriculum significantly increases technical mastery (Mean = 256 points, $d = 9.23$). This aligns training with Industry 4.0 demands (González-Hernández, 2020), particularly in strategic sectors such as advanced manufacturing, the hybrid PDCA-quantitative methodology: The use of tests and 95% confidence intervals strengthened the evaluation of pedagogical interventions, overcoming the limitations of previous qualitative studies (Morales Holguín & González Bello, 2021) and evidence of educational inequality.

The initial heterogeneity ($SD = 29.16$) suggested that non-standardized methodologies deepen inequalities, supporting (Díaz-Schery, 2024) on the need to democratize access to validated competencies.

This allows us to achieve goals such as: ensuring that the model is replicable in institutions with similar challenges of curriculum misalignment, particularly in developing countries, and that the 97% post-intervention efficiency provides a benchmark for educational policies focused on SDG 4 (quality education). This research not only confirms that updating and implementing the competency-based academic program is feasible, but also essential to reducing the academic-industry gap. I can assure you that any student who takes the course with the new design engineering subject will be able to take and pass the certification exam upon completion (focused on CSWA certification for

SolidWorks). It establishes that the semester in which this subject should be introduced or taught is preferably in the eighth grade.

The findings refute skepticism about the applicability of industrial methodologies (PDCA) in education, setting a precedent for data-driven curriculum reforms. Future studies should explore the integration of these certifications with soft skills for a comprehensive professional profile.

CONCLUSIONS

This research demonstrated that integrating subjects aligned with professional certifications in computer-aided design (CAD), focused on CSWA for SolidWorks and AutoCAD 2D, significantly increased the practical performance of industrial engineering students, achieving 97% effectiveness in skills acquisition. These results highlighted the need to restructure academic programs under teaching models established in international standards and continuous improvement through the PDCA cycle (Plan, Do, Check, Act). In this way, the study went beyond the diagnosis of training gaps by establishing a replicable model that directly links university education with the technological needs of Industry 4.0, contributing to the Sustainable Development Goals, particularly SDG 4 (quality education) and SDG 9 (industry, innovation, and infrastructure).

Based on the findings, two derivative research paths were identified. The first path, pedagogical-technological, focused interest on the incorporation of active learning methodologies.

—such as project-based learning or gamification—within the PDCA framework, with the aim of strengthening critical thinking, problem solving, and motivation toward professional certification in hybrid environments. The second route, institutional-industrial, proposes analyzing the effects of university-business links on curriculum updating, exploring how the participation of the productive sector in the design of academic programs can improve the employability and technological innovation of these case studies.

In summary, the model developed confirmed that training based on certifications and continuous improvement not only increased students' practical performance but also redefined the social and productive relevance of industrial engineering today.

Bibliography

Academia. (01 of 01 of 2025). <https://acaddemia.teachable.com/p/solidworks>. Retrieved from <https://acaddemia.teachable.com/p/solidworks>: <https://acaddemia.teachable.com/p/solidworks>

AUTODESK. (01 of 01 of 2025).

<https://www.autodesk.com/es/support/technical/article/caas/sfdarticles/sfdarticles/ESP/System-requirements-for-AutoCAD-2024-including-Specialized-Toolsets.html> (Journal of the University of the Basque Country).

Retrieved
from

<https://www.autodesk.com/es/support/technical/article/caas/sfdarticles/sfdarticles/ESP/System-requirements-for-AutoCAD-2024-including-Specialized-Toolsets.html>:

<https://www.autodesk.com/es/support/technical/article/caas/sfdarticles/sfdarticles/ESP/System-requirements-for-AutoCAD-2024-including-Specialized-Toolsets.html>

Autodesk. (2025). www.autodesk.com. Retrieved
from

https://www.autodesk.com/mx/products?cjdata=MXxOfDB8WXww&mktvar002=afc_mx_deeplink&AID=12741901&PID=8299320&SID=jkp_CjwKCAiAhP67BhAVEiwA2E_9gzO7UBLZ6q2aXXTrSa7aEvvAQL3_D7pUyNx6ExV4IuiNkITMUHE8NhoCrEEQAvD_BwE&cjevent=edf4a412ceca11ef801f88440a1eba23&affnam

Bailey, K. D. (1994). *Applied Social Research: A Tool for the Human Services*. New York: Macmillan Publishing Company.

Campbell, D. T. (1963). *Experimental and Quasi-Experimental Designs for Research*. Chicago: Houghton Mifflin Company.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences, introducing and explaining Cohen's d*. Lawrence Erlbaum Associates. .

Corporation, S. (2002-2025). www.solidworks.com. Retrieved
from https://www.solidworks.com/sites/default/filesd10/migration/2018-07/CSWASampleExam_1.pdf

Corporation, S. (2022). *CSWA Certification Guide*. Waltham, MA: Dassault Systèmes.

Crespo, D. (2019). *Use of computer-aided design programs in die design to obtain the hook piece*. Cuba: Avances.

Creswell, J. W. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: SAGE Publications (5th edition).

Díaz-Schery, C. A. (2024). *Labor competences: considerations for industrial engineers; the case of the University of Guantanamo*. University of Guantanamo.

Florida. (2024). Understanding Vocational and Technical Education: Information for Parents and Students. *Florida Access Network*, 1-3.

González-Hernández, I. J.-M. (2020). Competencies of industrial engineers in Industry 4.0. *Educational Research Electronics*, 22, e30.

Hernández Sampieri, R. F. (2014). *Research Methodology*. Mexico City: McGraw Hill Education (6th edition).

IES. (January 1, 2024). <https://iessoler.es/empresa/noticias/los-beneficios-de-trabajar-con-software-de-diseno->

2d-y-3d/. Retrieved from <https://iessoler.es/empresa/noticias/los-beneficios-de-trabajar-con-software-de-diseno-2d-y-3d/>: <https://iessoler.es/empresa/noticias/los-beneficios-de-trabajar-con-software-de-diseno-2d-y-3d/>

León, O. G. (2003). *Research Methods in Psychology and Education*. Madrid: McGraw Hill (3rd edition).

Metaute Paniagua, P. M., Flórez Osorio, G. A., Rúgeles Contreras, P. A., & Castaño, D. A. (2018). The revitalization of current teaching strategies: a necessity applicable to the teaching and learning processes of engineering students in the 21st century. *Lasallista Investig.*

Minitab. (January 1, 2024). <https://blog.minitab.com/es/como-elegir-entre-una-prueba-no-parametrica-y-una-prueba-parametrica>. Retrieved from <https://blog.minitab.com/es/como-elegir-entre-una-prueba-no-parametrica-y-una-prueba-parametrica>: <https://blog.minitab.com/es/como-elegir-entre-una-prueba-no-parametrica-y-una-prueba-parametrica>

Moen, R. &. (2010). *Circling Back: Clearing up Myths about the Deming Cycle and Seeing How It Keeps Evolving (2010)*.

Morales Holguín, A., & González Bello, E. O. (2021). *Diversity in university teaching and design practice in Mexico*. Costa Rica: Electronic Journal "Actualidades Investigativas en Educación".

Muñiz, J. (2018). *Classical test theory: Development, applications, and problems*. Madrid: Pirámide.

Naranjo-Pizano, G. (2019). *Engineering education*. Colombia: Lámpsakos.

Popper, K. R. (1959). *The Logic of Scientific Discovery*. London: Routledge.

reddit. (01 of 01 of 2025). https://www.reddit.com/r/engineering/comments/dr0oa8/how_to_improve_autocad_and_solidworks_skills/. Retrieved from https://www.reddit.com/r/engineering/comments/dr0oa8/how_to_improve_autocad_and_solidworks_skills/: https://www.reddit.com/r/engineering/comments/dr0oa8/how_to_improve_autocad_and_solidworks_skills/%3Ft%3Des-419

Rodríguez Mesa, F. J. (2021). *Study of creativity in engineering design in Project-Based Learning*. Colombia: National University of Colombia.

SOLIDWORKS. (January 1, 2025). <https://www.solidworks.com>. Retrieved from <https://www.solidworks.com>: <https://www.solidworks.com/es/certifications/mechanical-design-cswa-mechanical-design>

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