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2 **STATICALC: AN INTERACTIVE WEB-BASED LEARNING TOOL**
3 **WITH INTEGRATED CALCULATORS FOR STATICS OF RIGID**
4 **BODIES FOR CIVIL ENGINEERING STUDENTS OF MSU-GENERAL**
5 **SANTOS**

6 An Undergraduate Thesis
7 presented to the
8 Civil Engineering Department
9 College of Engineering
10 Mindanao State University
11 General Santos City

12 In partial fulfillment
13 of the requirements for the degree
14 Bachelor of Science in Civil Engineering

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Chapter 1

Introduction

20 1.1 Background of the Study

21 Engineering education is the process of acquiring the knowledge, skills, and competencies necessary to prepare individuals for professional engineering practice. One of its 22 foundational areas is *Engineering Mechanics*, which concerns the effects of forces and 23 energy on bodies. It is divided into two branches: *Statics* and *Dynamics*. Among these, 24 *Statics of Rigid Bodies* plays a crucial role in the engineering curriculum because it es- 25 tablishes the principles of equilibrium and force analysis, which are required in advanced 26 engineering courses. It focuses on analyzing how forces and moments act on particles 27 and rigid bodies that remain at rest or in equilibrium.

29 In the Civil Engineering curriculum of Mindanao State University – General San-
30 tos (MSU-Gensan), as stated in *MSU Board Resolution No. 375, s. 2017*, *Statics of*
31 *Rigid Bodies (ENS 161)* serves as one of the core foundation courses in Engineering
32 Mechanics. It is a prerequisite for *Dynamics of Rigid Bodies (ENS 162)* and *Mechanics*
33 *of Deformable Bodies (CVE 155)*, both of which are essential for higher-level design and
34 analysis. In other engineering programs, such as Mechanical, Electrical, and Agricul-
35 tural and Biosystems Engineering, Statics also functions as a preparatory course that
36 cultivates analytical and problem-solving skills fundamental to engineering education.
37 Failure in this subject often results in academic delays, as it serves as a prerequisite for
38 subsequent major engineering courses. (Salami and Perry)

39 Despite its foundational importance, *Statics of Rigid Bodies* remains one of the most
40 conceptually and mathematically demanding subjects in the engineering curriculum.
41 The discipline requires a solid grasp of trigonometry, geometry, and algebra. With-
42 out this mathematical foundation, students struggle to analyze forces, moments, and

43 equilibrium conditions accurately.

44 A study conducted at Baguio Central University revealed that incoming first-year
45 students exhibited mathematical difficulties that affected their readiness for college-level
46 subjects, particularly in algebra (Felix). Similarly, research among first-year students at
47 Mandaue City College found that math anxiety, a feeling of tension and apprehension
48 when solving mathematical problems, negatively correlates with academic performance,
49 meaning that higher levels of math anxiety are associated with lower academic achieve-
50 ment. (Incierto et al.)

51 The use of calculators and digital tools has been shown to help reduce computa-
52 tional errors and mitigate math anxiety by allowing students to focus on conceptual
53 understanding rather than manual computation. (Segarra and Cabrera-Martínez) Stud-
54 ies further indicate that combining calculator use with structured instruction enhances
55 problem-solving confidence and overall comprehension.

56 In addition to mathematical difficulties, students face several conceptual and proce-
57 dural challenges in learning Statics of Rigid Bodies. Many struggle to connect physical
58 concepts with their mathematical representations, often perceiving forces and moments
59 as abstract quantities rather than as real interactions between bodies. This lack of con-
60 ceptual understanding frequently leads to errors in constructing Free Body Diagrams
61 (FBDs), such as omitting essential forces, misplacing directions, or confusing internal
62 and external forces. Learners also experience difficulty distinguishing between related
63 concepts such as moments, couples, and resultant forces, as well as visualizing how forces
64 act within two- and three-dimensional structures. Moreover, students often rely on rote
65 memorization of formulas and procedural steps without fully grasping their physical
66 meaning, resulting in shallow learning and difficulty applying knowledge to new prob-
67 lem situations. These difficulties are further compounded by traditional lecture-based
68 teaching methods, which limit interaction, visualization, and engagement, factors essen-

69 trial for developing a deeper understanding of statics principles (Salami and Perry).

70 Students currently taking *Statics of Rigid Bodies* at MSU-Gensan are generally

71 second-year Civil Engineering students, typically aged 19 to 20. This group belongs

72 to Generation Z, often referred to as digital natives, individuals who have grown up sur-

73 rounded by computers, smartphones, and the internet. According to Szymkowiak et al.,

74 educators should integrate modern, Internet-based learning tools, such as mobile appli-

75 cations and online videos, alongside traditional instruction to align with this generation's

76 learning preferences. Similarly, Zeichner emphasized that learning through simulations

77 fosters a deeper understanding of abstract concepts than conventional teaching methods.

78 Consistent with the findings of De La Hoz et al., traditional lecture-based approaches

79 in statics are insufficient to address these learning barriers, highlighting the need for

80 innovative digital tools that enhance engagement, comprehension, and problem-solving

81 skills among engineering students. In the context of *Statics of Rigid Bodies*, where stu-

82 dents often struggle with visualization and conceptualization, these insights underscore

83 the need for interactive, technology-supported learning environments.

84 Given these mathematical and conceptual challenges, there is a clear need for a

85 supplementary, technology-driven learning resource that can combine computational

86 assistance, visualization, and interactivity. To address this need, the researchers devel-

87 oped *StatiCalcs*, an interactive web-based learning tool designed specifically for *Statics*

88 of *Rigid Bodies*. The platform organizes topics according to the major chapters of the

89 course: Introduction to Statics, Force Systems, Equilibrium, Structures, and Distributed

90 Loads. And it integrates calculators that generate step-by-step solutions, results, and

91 free-body diagrams in real time. By merging conceptual explanations with computation

92 and visualization, *StatiCalc* aims to enhance students' understanding, reduce learning

93 anxiety, and reinforce classroom instruction.

94 Recognizing students' characteristics, the researchers saw potential in developing a

95 digital learning platform that aligns with students' familiarity with technology while
96 addressing learning challenges in *Statics of Rigid Bodies*. Through this innovation, the
97 study seeks to bridge the gap between traditional teaching methods and digital learn-
98 ing practices by providing MSU-Gensan Civil Engineering students with an accessible,
99 interactive, and effective academic support tool for studying *Statics of Rigid Bodies*.

100 **1.2 Statement of the Problem**

101 This study aims to determine the level of perception of Civil Engineering students
102 and instructors of MSU-General Santos on the developed web-based learning tool, *Stat-*
103 *iCalc*, designed for the subject *Statics of Rigid Bodies*. The study seeks to assess how
104 the tool performs in terms of usability, accessibility, and user satisfaction.

105 Specifically, this study aims to answer the following questions:

106 1. What is the level of perception of Civil Engineering students of MSU-General
107 Santos regarding *StatiCalc* in terms of:

108 1.a. Usability

109 1.b. Accessibility

110 1.c. Satisfaction

111 2. What is the level of perception of Civil Engineering instructors of MSU-General
112 Santos regarding *StatiCalc* in terms of:

113 2.a. Usability

114 2.b. Accessibility

115 2.c. Satisfaction

116 3. Is there a significant difference between the level of perception of students and
117 instructors in terms of usability, accessibility, and satisfaction?

¹¹⁸ **1.3 Scope and Limitations**

¹¹⁹ This study focuses on the design, development, and evaluation of a web-based learn-
¹²⁰ ing tool, StatiCalc, intended to assist Civil Engineering students of Mindanao State
¹²¹ University – General Santos in studying the subject Statics of Rigid Bodies. The web-
¹²² site covers all major topics in Statics, including force systems, equilibrium, structures,
¹²³ centroids, moments of inertia, and friction. It integrates conceptual explanations and
¹²⁴ calculators to help users understand and solve problems interactively. The evaluation
¹²⁵ of the tool focuses on three aspects: usability, accessibility, and user satisfaction.

¹²⁶ The respondents of the study are limited to Civil Engineering students, specifically
¹²⁷ second-year students currently enrolled in Statics of Rigid Bodies and senior students
¹²⁸ who have already taken the subject, as well as instructors teaching the same course in
¹²⁹ the College of Engineering of MSU-General Santos during the Academic Year 2025–2026.

¹³⁰ The data were collected through survey questionnaires administered after the respon-
¹³¹ dents had explored and used the developed website

¹³² The study does not measure students' academic performance or actual improvement
¹³³ in examination results. It also excludes students and instructors from other engineer-
¹³⁴ ing programs and subjects such as Dynamics and Mechanics of Materials. Moreover,
¹³⁵ the study focuses solely on perceptions regarding the usability and effectiveness of the
¹³⁶ developed tool and does not account for external factors such as internet connectivity,
¹³⁷ learning motivation, or prior knowledge of the respondents.

¹³⁸ **1.4 Significance of the Study**

¹³⁹ This study is conducted to develop a web-based learning tool, *StatiCalc*, which aims to
¹⁴⁰ support the teaching and learning of Statics of Rigid Bodies among Civil Engineering
¹⁴¹ students of Mindanao State University – General Santos. The results and outcomes of

¹⁴² this research are expected to benefit the following:

¹⁴³ **Students.** The developed website serves as a supplementary learning tool that allows
¹⁴⁴ students to practice problem-solving in Statics of Rigid Bodies through an interactive
¹⁴⁵ and user-friendly platform. As learners today are inclined toward technology-based
¹⁴⁶ education, *StatiCalc* provides an accessible and engaging way to enhance understanding
¹⁴⁷ and reinforce classroom instruction.

¹⁴⁸ **Teachers.** The tool can be integrated into teaching strategies to improve the deliv-
¹⁴⁹ ery of complex statics concepts. It may also assist instructors in providing visual and
¹⁵⁰ computational demonstrations that complement lectures and classroom exercises.

¹⁵¹ **School Administration.** The study may provide the institution with an example
¹⁵² of how digital learning tools can be developed and implemented to improve academic
¹⁵³ performance. It may also encourage future initiatives that promote technology-driven
¹⁵⁴ learning in other engineering courses.

¹⁵⁵ **Future Researchers.** This study may serve as a reference for future studies that
¹⁵⁶ aim to develop similar educational tools or further improve *StatiCalc* by adding new
¹⁵⁷ features, expanding its scope, or evaluating its long-term impact on student learning.

¹⁵⁸ 1.5 Conceptual Framework

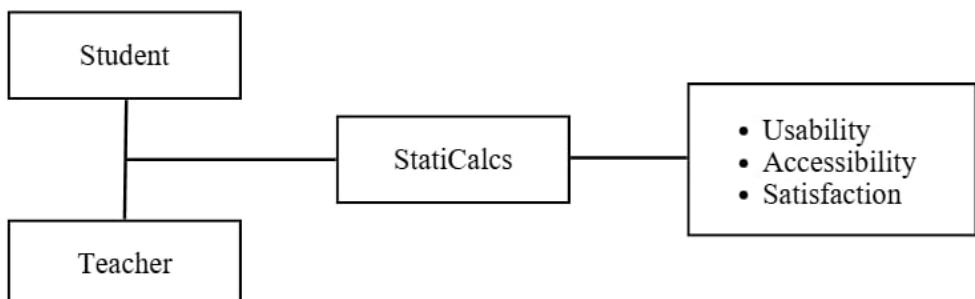


Figure 1. Conceptual Framework

¹⁵⁹ **1.6 Definition of Terms**

¹⁶⁰

Statics of Rigid Bodies

Statics of Rigid Bodies is a branch of engineering mechanics that deals with the study of forces and their effects on bodies that are assumed to remain perfectly rigid. It focuses on determining the conditions of equilibrium, where the sum of all forces and moments acting on a body equals zero to ensure structural stability. This is the course that serves as the primary focus of the web-based learning tool developed by the researchers. It involves the study of forces, moments, and their effects on bodies that are assumed to remain perfectly rigid.

Equilibrium

Equilibrium refers to the condition of a body when the sum of all forces and the sum of all moments acting upon it are equal to zero, meaning the body remains at rest or moves with constant velocity.

**Free Body Diagram
(FBD)**

A Free Body Diagram (FBD) is a simplified graphical representation of a body or system isolated from its surroundings, showing all external forces and moments acting on it. It is used to visualize and analyze the forces acting on the body.

¹⁶¹

Web-Based Learning Tool A web-based learning tool is an interactive educational platform or software accessible through the internet, designed to facilitate learning through engagement, visualization, and feedback.

Developmental Research Developmental research is a methodological approach that focuses on the systematic design, development, and evaluation of instructional programs, processes, or products to improve educational practice.

Perception Perception is the process by which individuals interpret and organize sensory information to create meaning and understanding of their environment. In educational research, it often refers to how learners view or experience a certain tool, concept, or environment.

Usability Usability refers to the degree to which a product, tool, or interface allows users to achieve specific goals effectively, efficiently, and satisfactorily in a defined context.

Accessibility	Accessibility is the design of products, systems, or environments that can be used by people of all abilities, including those with disabilities, to perceive, understand, navigate, and interact effectively.
Satisfaction	Satisfaction refers to the degree to which users feel content or fulfilled with a product, service, or experience, often reflecting how well it meets their expectations and needs.
Supplementary	Supplementary refers to something that is added to complete, enhance, or support something else. In the context of education or research, supplementary materials or tools provide additional resources that aid in understanding, reinforcement, or enrichment of learning.

Digital Natives

Digital natives are individuals who have grown up

during the age of digital technology, such as

computers, smartphones, and the internet, and

are thus comfortable using these tools in daily life.

These refer to the generational group that

represents the target population of the study.

They are individuals who have grown up in the

age of digital technology and are highly familiar

with the use of computers, the Internet, and

web-based applications.

Generation Z

Generation Z refers to the demographic cohort

born roughly between the mid-to-late 1990s and

the early 2010s. They are characterized by their

familiarity with digital technology, internet

connectivity, and social media from an early age.

Generation Z is often described as tech-savvy,

socially aware, and highly engaged with online

communication and learning environments. These

refer to individuals belonging to Generation Z, the

target population of the study. They grew up in

the digital age, making them highly adept at

using technology, the Internet, and web-based

learning platforms.

Chapter 2

Review of Related Literature

167 Statics of Rigid Bodies

Statics of Rigid Bodies, commonly referred to as *Engineering Statics*, is a branch of engineering mechanics that focuses on the study of forces, moments, and their effects on bodies that remain at rest or in equilibrium. It serves as one of the most fundamental subjects in engineering education, as it establishes the foundational principles necessary for advanced engineering courses.

In the Civil Engineering curriculum of Mindanao State University – General Santos (MSU-Gensan), as stated in MSU Board Resolution No. 375, s. 2017, *Statics of Rigid Bodies* (ENS 161) serves as a core foundation course and a prerequisite to *Dynamics of Rigid Bodies* (ENS 162) and *Mechanics of Deformable Bodies* (CVE 155), both of which are essential for advanced design and analysis. Similarly, in other engineering disciplines, such as Mechanical, Electrical, and Agricultural and Biosystems Engineering, *Statics* also serves as a preparatory course that cultivates the analytical and problem-solving skills fundamental to engineering education. Failure in this subject often results in academic delays, as it serves as a prerequisite for subsequent major engineering courses. Overall, mastering *Statics of Rigid Bodies* is essential not only for academic progression but also for developing the critical thinking and analytical reasoning required of future engineers.

185 Beyond academics, the principles of *Statics* are extensively applied in real-
186 world engineering practice. They are used in designing safe and efficient systems such as
187 buildings, bridges, dams, machines, and various mechanical components. Civil engineers
188 use *Statics* to ensure that structural loads are properly supported, mechanical engineers
189 apply it to design stable machine elements, and electrical engineers use it to develop

190 reliable mounting and support systems. Mastery of *Statics* thus enables engineers to
191 design structures and mechanisms that remain safe, stable, and functional under various
192 loading conditions.

193 **Challenges in Learning Statics**

194 Learning *Statics of Rigid Bodies* has been widely recognized as one of the
195 most challenging areas in engineering education due to its high conceptual and analytical
196 demands. Salami and Perry (2025) explored the perceptions of students regarding the
197 difficulties they face in *Statics* and identified a wide range of conceptual, procedural, and
198 affective barriers. Students often struggled to connect mathematical symbols with their
199 physical meanings, treating forces and moments as abstract quantities rather than as
200 real interactions between bodies. Many had difficulty constructing *Free Body Diagrams*
201 (*FBDs*), frequently misplacing force directions, omitting reactions, or confusing internal
202 and external forces. They also expressed challenges in distinguishing between related
203 concepts such as moments, couples, and resultants, and in visualizing force systems
204 within two- or three-dimensional contexts. Beyond conceptual gaps, the study also
205 highlighted emotional and instructional factors: students often described *Statics* as a
206 difficult and anxiety-inducing subject, with fast-paced lectures and heavy workloads
207 compounding their struggles. The authors concluded that these issues call for more
208 interactive, visualization-based, and student-centered learning environments to promote
209 deeper comprehension and engagement.

210 Complementing the students' perspective, Salami, Oladipo, and Perry (2024)
211 examined *Statics* instruction from the viewpoint of faculty members and teaching assis-
212 tants. Their findings revealed that educators recognized similar conceptual deficiencies
213 among students, particularly in applying theoretical principles to problem-solving and in
214 constructing logical reasoning processes. Faculty respondents attributed these difficul-

215 ties to gaps in prerequisite mathematical knowledge, limited spatial visualization skills,
216 and a tendency among students to rely heavily on memorization. Furthermore, instruc-
217 tors noted that traditional lecture-based instruction often fails to engage students or
218 accommodate diverse learning styles. Faculty members also cited structural challenges
219 such as large class sizes, limited time for individualized feedback, and insufficient re-
220 sources for implementing interactive or simulation-based teaching methods. The study
221 emphasized that overcoming these persistent learning barriers requires instructional in-
222 novations, such as technology-enhanced tools, simulations, and guided visualization plat-
223 forms, that bridge the gap between abstract theory and practical understanding.

224 **Web-Based Learning**

225 In today's generation, the internet has become widely accessible, allowing peo-
226 ple to obtain information more easily than through traditional printed materials. Unlike
227 books, online resources can be accessed anytime and anywhere, using various devices
228 such as computers, tablets, or smartphones, as long as there is an internet connection.
229 This accessibility has transformed how individuals learn and share knowledge.

230 *Web-based learning*, also known as *online learning* or *e-learning*, utilizes
231 internet-based platforms to deliver educational content and facilitate interaction be-
232 tween students and instructors. It provides learners with the flexibility to study at
233 their own pace and convenience, overcoming barriers of time and location. Moreover,
234 it encourages the use of multimedia tools—such as videos, simulations, and interactive
235 modules—that enhance engagement and improve understanding of complex topics. As
236 education continues to adapt to technological advancements, *web-based learning* has
237 become an essential component of modern instruction. It supports independent learn-
238 ing, promotes collaboration through virtual classrooms, and offers a more inclusive and
239 adaptive learning environment for digital-native students who are already accustomed

²⁴⁰ to using technology in their daily lives.

²⁴¹ According to Mishra *et al.* (2022), the rise of *e-learning* has greatly accel-
²⁴² erated the global adoption of online learning, making it a dominant educational model
²⁴³ in many countries. Their study revealed that as digital connectivity becomes more
²⁴⁴ pervasive, *e-learning*—particularly the emerging online learning systems—is expected
²⁴⁵ to become the standard mode of instruction across multiple sectors. The widespread
²⁴⁶ availability of web-based technologies enables a seamless, data-driven learning experi-
²⁴⁷ ence that supports continuous access to educational resources worldwide. As education
²⁴⁸ continues to evolve with technological advancements, *web-based learning* remains a vital
²⁴⁹ component of modern instruction, supporting independent learning, promoting collab-
²⁵⁰ oration through virtual classrooms, and fostering an adaptive learning environment for
²⁵¹ students in the digital age.

²⁵² **StatiCalcs**

²⁵³ Söllradl (2022), in the study “*Symbolic Calculation of Beam Structures: Dig-*
²⁵⁴ *italisation of Teaching Strength of Materials at University,*” conducted at the Institute
²⁵⁵ for Applied Mechanics, TU Graz, discussed the digitalisation initiative at Graz Technical
²⁵⁶ University (TU Graz) that aims to enhance digital learning in *Engineering Mechanics*
²⁵⁷ across several departments. The researcher developed an automated and scalable sys-
²⁵⁸ tem designed to generate individualized assignments for students, supporting a more
²⁵⁹ efficient and interactive approach to learning.

²⁶⁰ To accomplish this, the researcher utilized a Python-based framework capable
²⁶¹ of automatically creating, distributing, and solving assignments related to beam struc-
²⁶² tures. Instead of relying solely on numerical solutions, the system emphasized symbolic
²⁶³ computation using the *Euler–Bernoulli beam theory* to formulate and solve systems of
²⁶⁴ linear equations. This method provided learners with a clearer understanding of the me-

265 mechanical behavior of beam structures by reinforcing analytical and theoretical principles
266 rather than focusing only on numerical outputs.

267 The developed tool also allowed for the modeling of beams with varying flexu-
268 ral and axial rigidity, included stiff elements, and supported the use of different types of
269 joints and bearings at the nodes. Through this approach, the researcher demonstrated
270 how digitalization and automation can be effectively integrated into engineering educa-
271 tion to promote personalized learning, minimize manual workload for instructors, and
272 enhance students' analytical and problem-solving skills.

273 Gfrerer, Michael H., Benjamin Marussig, Katharina Maitz, and Mia M. Banger
274 (2024), in their study titled "*Teaching Mechanics with Individual Exercise Assignments*
275 and *Automated Correction*," introduced an automated correction system for exercise
276 assignments designed to address the challenges of manually creating and grading stu-
277 dent work in large engineering classes. Traditional assignment methods often limit the
278 number of exercises that can be provided, resulting in a smaller problem pool relative
279 to the number of students. This restriction makes it difficult to assess whether learners
280 can independently solve problems and encourages unreflective task replication, which
281 hinders conceptual understanding and leads to inaccurate self-assessment.

282 To overcome these limitations, the researchers developed a scalable framework
283 for generating, distributing, and automatically correcting individualized exercises in
284 topics such as *statics*, *strength of materials*, *dynamics*, and *hydrostatics*. Their system
285 allows each student to receive a unique set of problems, promoting academic integrity
286 and active engagement. A quantitative survey conducted among students enrolled in
287 a statics course demonstrated strong acceptance of the tool, with feedback indicating
288 that it enhanced self-directed and reflective learning. The authors concluded that the
289 automated correction system provides significant added value in mechanics education
290 by fostering independent learning and reducing instructor workload, thereby improving

291 the overall efficiency and quality of teaching in engineering mechanics courses.

292 Building upon these findings, the researchers developed *StatiCalcs*, a web-based supplementary learning tool designed specifically for students taking *Statics of Rigid Bodies*. The platform provides an interactive computational environment where users can perform statics-related analyses, visualize results, and verify manual solutions. 296 *StatiCalcs* is not intended to replace traditional instruction but to serve as a supplementary resource that reinforces theoretical and analytical concepts through immediate 297 computational feedback and graphical representation.

299 The structure and content of *StatiCalcs* are based on key topics presented 300 in *Meriam and Kraige's Engineering Mechanics: Statics, 5th Edition*, one of the most 301 widely used references in engineering education. The system consists of four core chapters: *Force Systems*, *Equilibrium*, *Structural Analysis*, and *Distributed Loads*. The *Force Systems* module enables users to determine the resultant of both two-dimensional and 304 three-dimensional force systems using the tip-to-tail graphical method and the analytical 305 component method. The *Equilibrium* module facilitates the analysis of concurrent, 306 parallel, and general force systems by applying the equations of equilibrium. Meanwhile, 307 the *Structural Analysis* module features a Truss Calculator that computes internal member 308 forces using the method of joints and the method of sections, allowing students to 309 verify their manual computations. Lastly, the *Distributed Loads* module supports the 310 analysis of beams and other statically determinate structures subjected to linearly or 311 non-linearly varying loads.

312 By combining computational accuracy, visual interpretation, and automation, 313 *StatiCalcs* provides a technologically enhanced platform that aligns with modern 314 engineering education practices. As a supplementary educational tool, it bridges the 315 gap between theoretical instruction and applied problem-solving by allowing learners 316 to test, visualize, and confirm their understanding of fundamental statics principles.

³¹⁷ Ultimately, *StatiCalcs* contributes to improving student engagement, conceptual com-
³¹⁸ prehension, and analytical proficiency in the study of *Statics of Rigid Bodies*.

³¹⁹ Several existing web-based calculators have been developed to support learn-
³²⁰ ing in mathematics and engineering. *Symbolab*, for instance, is a widely used online
³²¹ computational platform that focuses primarily on algebraic manipulation, calculus, and
³²² introductory physics. It employs symbolic computation to provide step-by-step solu-
³²³ tions, helping learners understand the procedural flow of mathematical problem-solving
³²⁴ (Symbolab, 2024). Similarly, *GeoGebra* offers a dynamic learning environment that in-
³²⁵ tegrates geometry, algebra, and graphing functionalities. Its interactive visualization
³²⁶ capabilities make it particularly useful for exploring mathematical relationships and
³²⁷ geometric principles in an intuitive manner (Hohenwarter & Lavicza, 2022).

³²⁸ Another notable platform is *SkyCiv*, which serves as a specialized online tool
³²⁹ for structural and civil engineering applications. *SkyCiv* allows users to perform two-
³³⁰ dimensional and three-dimensional analyses of beams, trusses, and frames, making it a
³³¹ practical choice for both professionals and students. However, its advanced features are
³³² typically accessible through paid subscriptions, which can limit accessibility for some
³³³ learners (SkyCiv, 2024).

³³⁴ In contrast to these existing platforms, *StatiCalcs* was developed as a free,
³³⁵ topic-specific web-based learning tool dedicated solely to the study of *Statics of Rigid*
³³⁶ *Bodies*. Unlike general-purpose platforms, *StatiCalcs* focuses exclusively on the funda-
³³⁷ mental concepts of engineering mechanics, including *Force Systems*, *Equilibrium*, *Struc-*
³³⁸ *tural Analysis*, and *Distributed Loads*. This narrow yet specialized scope allows the
³³⁹ system to provide a more structured, focused, and educationally aligned approach to
³⁴⁰ problem-solving in statics.

³⁴¹ Furthermore, *StatiCalcs* integrates both computational and visualization fea-
³⁴² tures tailored to the statics curriculum. Users can input problem parameters, perform

343 step-by-step calculations, and visualize results such as force systems, truss configura-
344 tions, and distributed load diagrams. These functions make the platform an effective
345 supplementary resource for verifying manual solutions, reinforcing theoretical lessons,
346 and enhancing student understanding of equilibrium and force interaction principles.

347 By focusing specifically on statics and maintaining open accessibility, *Stat-*
348 *iCalcs* addresses a gap in the availability of free, academically oriented web-based
349 tools for engineering education. It provides a targeted, user-friendly, and pedagogi-
350 cally consistent alternative to general-purpose platforms such as *Symbolab*, *GeoGebra*,
351 and *SkyCiv*. Through its combination of computational precision, visual learning sup-
352 port, and subject-specific design, *StatiCalcs* aligns closely with current trends in digital
353 and technology-enhanced learning, contributing to the ongoing evolution of engineering
354 education.

355 Technology Based Learning

356 Study of (De La Hoz, J. L., et al.) states how self-explanation activities
357 may support student learning in statics. Specifically, this study examines the char-
358 acteristics of student self-explanations of worked examples and their relationship with
359 students' conceptual change. The findings suggest a relationship between the type of
360 worked example, students' approaches to self-explaining, and their conceptual change
361 and problem-solving skills in statics. To increase the quality of the students' explana-
362 tions and to improve their conceptual understanding, additio

363 El-Shaimaa Talaat Abumandour (2022), "Applying E-Learning System for En-
364 gineering Education – Challenges and Obstacles," emphasized the rapid technological
365 advancements of the 21st century that have transformed educational delivery methods.
366 The researcher noted that the continuous improvement of technology has led to the emer-
367 gence of e-learning as a modern instructional approach widely adopted by educational

368 institutions, public organizations, and academic libraries. The researcher highlighted
369 that engineering education is increasingly moving toward a blended learning model,
370 which effectively integrates traditional “Face to face” instruction with computer-assisted
371 methodologies and internet-based learning. This hybrid approach enhances accessibility,
372 flexibility, and engagement among learners.

373 The study also outlined several challenges and obstacles that stakeholders,
374 including teachers, professors, and librarians, must address to fully develop and sus-
375 tain effective e-learning systems. These challenges include ensuring technological readi-
376 ness, maintaining instructional quality, and supporting both instructors and students
377 in adapting to digital learning environments. The researcher further proposed recom-
378 mendations aimed at strengthening the connection between e-learning and engineering
379 education, thereby promoting a more adaptive, innovative, and inclusive academic ex-
380 perience.

381 This correlates with our Web-based learning method that utilizes the Internet
382 as a platform for delivering educational content, simulations, and interactive experi-
383 ences. It allows learners to access information and perform tasks beyond the limits of
384 traditional classroom settings. This mode of learning promotes flexibility, self-paced
385 study, and accessibility, which are highly beneficial in modern education. With the con-
386 tinuous advancement of technology and the widespread availability of the Internet, it
387 has become increasingly important for educational institutions to adopt innovative tools
388 and platforms that enhance the learning process. Integrating technology into education
389 not only broadens access to knowledge but also encourages independent learning and
390 practical application of theoretical concepts.

391 The target population of this web-based learning tool are students currently
392 enrolled in Statics of Rigid Bodies, typically second-year engineering students. This
393 subject is a core component of the engineering curriculum, serving as the foundation

394 for more advanced courses such as mechanics of materials, structural analysis, and dy-
395 namics. However, many students find statics challenging due to the complexity of force
396 interactions and the abstract nature of equilibrium concepts. Through web-based tools,
397 learners can engage with interactive calculators, visualizations, and simulations that
398 reinforce computational techniques and problem-solving strategies related to statics.

399 These students belong to the generation that has grown up alongside rapid
400 technological advancement. Commonly referred to as digital natives, they are accus-
401 tomed to using online platforms, mobile applications, and digital resources in their daily
402 lives. This familiarity with technology makes web-based learning an appropriate and
403 effective approach for their academic environment. By integrating educational content
404 with interactive computation, web-based learning tools such as StatiCalcs align with
405 the learning habits of modern students, providing a convenient, accessible, and engag-
406 ing platform for applying engineering principles.

407 Overall, web-based learning represents a significant shift in educational de-
408 livery, supporting the development of both technical competence and digital literacy
409 among engineering students.

410

Chapter 3

411

Methodology

412 This chapter presents the research method, respondents, locale, instrument,
413 and procedure used in the study. It explains how the research will be conducted to
414 determine the perceptions of Civil Engineering students and faculty toward *StatiCalc*,
415 an interactive web-based learning tool developed for the subject Statics of Rigid Bodies.

416 **3.1 Research Method**

417 This study will use a quantitative research method, which focuses on collecting
418 and analyzing numerical data to describe patterns, relationships, and differences among
419 variables. According to Apuke (2017), quantitative research involves a systematic in-
420 vestigation that uses statistical techniques to produce objective and measurable results.
421 This method is appropriate for the present study because it seeks to gather data from
422 Civil Engineering students and instructors to assess and compare their perceptions of
423 the developed web-based learning tool, *StatiCalc*.

424 Specifically, a correlational quantitative approach will be applied. As defined
425 by Creswell (2014), this approach examines the relationship or difference between two
426 or more variables to determine whether a significant association exists. In this study, it
427 will be used to determine the significant difference between the perceptions of students
428 and instructors regarding the usability, accessibility, and satisfaction of *StatiCalc*. This
429 method will allow the researchers to statistically analyze the degree to which these two
430 groups differ in their perceptions, providing insights into the effectiveness and acceptance
431 of the developed learning tool across users.

⁴³² **3.2 Research Respondents**

⁴³³ The respondents of this study will be selected Bachelor of Science in Civil
⁴³⁴ Engineering students and teaching faculty from the College of Engineering at Mindanao
⁴³⁵ State University – General Santos (MSU-Gensan). The student respondents will include
⁴³⁶ second-year and higher-level Civil Engineering students who are either currently enrolled
⁴³⁷ in or have already completed the course Statics of Rigid Bodies (ENS 161). This selection
⁴³⁸ ensures that participants have sufficient background and experience with the subject,
⁴³⁹ allowing them to provide reliable feedback on the developed web-based learning tool,
⁴⁴⁰ *StatiCalc*. The faculty respondents, on the other hand, will consist of instructors who
⁴⁴¹ are currently teaching or have previously taught Statics of Rigid Bodies, as they can
⁴⁴² provide expert evaluation regarding the tool's usability, accessibility, and relevance to
⁴⁴³ the course content.

⁴⁴⁴ **3.3 Research Locale**

⁴⁴⁵ This study will be conducted at the College of Engineering, Mindanao State
⁴⁴⁶ University – General Santos (MSU-Gensan), located in Fatima, General Santos City.
⁴⁴⁷ The college offers various engineering programs, including Civil, Mechanical, Electrical,
⁴⁴⁸ and Agricultural and Biosystems Engineering. The research will primarily focus on the
⁴⁴⁹ Engineering Building, where most classroom lectures, computer laboratory sessions, and
⁴⁵⁰ faculty offices are situated. This location is ideal for the study since it houses both the
⁴⁵¹ student respondents taking Statics of Rigid Bodies and the faculty members teaching
⁴⁵² the subject.

453 3.4 Research Procedure

454 The researchers will conceptualize, design, and develop a web-based learning
455 tool called *StatiCalc*, an interactive platform with integrated calculators specifically de-
456 signed for the subject Statics of Rigid Bodies. The system will undergo evaluation and
457 approval by experts in the field to ensure its accuracy, functionality, and relevance to the
458 course. A researcher-made questionnaire will then be developed to measure the level of
459 perception of Civil Engineering students and instructors in terms of usability, accessibil-
460 ity, and satisfaction. Before data gathering, a formal letter of permission to conduct the
461 study will be submitted to the Dean of the College of Engineering at Mindanao State
462 University–General Santos.

463 The researchers will administer the questionnaire to the selected respondents
464 composed of Civil Engineering students and faculty members. After data collection, the
465 gathered responses will be encoded, organized, and subjected to statistical analysis.

466 3.5 Statistical Tools

467 A researcher-made instrument will be utilized in conducting this study. The
468 tool will employ a five-point Likert scale to measure the level of perception of both
469 students and instructors regarding the developed web-based learning tool, *StatiCalc*.
470 The survey will assess their perceptions in terms of usability, accessibility, and satisfa-
471 ction. Each item in the questionnaire will be rated on a scale ranging from 1 (Strongly
472 Disagree) to 5 (Strongly Agree), allowing for quantitative analysis of the respondents'
473 perceptions toward the tool's overall usability, accessibility, and user satisfaction.

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