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USER-CENTERED DEVELOPMENTAND EXPERIENCE EVALUATION OF A COMPUTER- ASSISTED SYSTEMFOR ICT CONTENT CREATIONIN SPECIAL NEEDS EDUCATIONAT SANTACRUZ INTEGRATED NATIONAL HIGH SCHOOL

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Abstract- The study focuses on the user-centered development and experience evaluation of a computer-assisted system designed for ICT content creation in special needs education at Santa Cruz Integrated National High School. The primary objective is to enhance educational equity and inclusion by providing customized, engaging, and accessible educational content tailored to SNED (Special Needs Education) learners' unique needs. The research involves developing the tool, designing user-friendly instructional materials, assessing the tool's effectiveness, and gathering data to improve teacher-student relationships. The study highlights the importance of investing in technology-driven solutions for learners with special needs to promote educational equity and inclusion. The tool's features, such as adaptive learning algorithms, customizable materials, sign language functionality, and augmented reality, ensure that it caters to the diverse needs of SNED learners. Feedback from teachers and students indicates that the tool is user-friendly and effective in improving the learning experience. The iterative development process, which involved multiple stages of prototyping, testing, and refinement, ensured that the tool met the specific needs of its users. The study concludes that the developed computer-assisted technology tool effectively enhances the learning process for SNED learners and recommends further research, continuous professional development for teachers, regular updates to the tool, and collaboration among stakeholders for successful implementation and adoption.

Keywords: SNED Learners, SNED Education, ICT Content, User- Centered Development, Adaptive Learning, Inclusive Class, Iterative Development Process

I- INTRODUCTION

The rapid advancement of technology has brought about significant changes in the educational landscape, providing new opportunities and challenges for teachers and learners, as mentioned by Anderson and Larson (2022). In the special needs education (SNED) context, these technological innovations offer unique tools to enhance learning experiences and accessibility for students with diverse needs. However, despite these advances, there remains a critical gap in the availability and utilization of customized digital tools specifically designed to meet the needs of SNED learners. This research paper focuses on developing a computer-assisted technology as a tool for creating ICT content tailored to SNED learners in the Sub-Office of Santa Cruz.

SNED learners often face challenges that hinder their access to quality education, such as a lack of personalized learning materials, limited teacher training on assistive technologies, and inadequate resources that cater to their unique learning needs cited by Hossain and Harris (2023). These issues are compounded by the scarcity of digital tools and tools that are specifically designed to facilitate the teaching of ICT content to SNED students. While there is a growing body of research on the use of technology in special education, there is still a considerable gap in the development of tools that are both accessible and adaptable to the individual learning requirements of SNED students in local contexts, such as the District of SantaCruz.

Despite the increased focus on inclusive education, many SNED programs continue to use traditional teaching methods that may not fully address the specific needs of these learners. The absence of specialized digital tools exacerbates this problem, leading to unsatisfactory learning conditions where SNED learners cannot engage with ICT content effectively. Current tools often lack customization options, do not support diverse learning modalities, and fail to provide an inclusive environment that caters to different types of disabilities, such as visual, auditory, cognitive, or motor impairments. Therefore, there is a pressing need to develop a dedicated computer-assisted technology tool to bridge this gap and provide a more tailored approach to teaching ICT content to SNED learners.

The decision to focus on developing a computer-assisted technology tool for SNED learners is grounded in the need to enhance educational equity and inclusion in the Sub-Office of Santa Cruz. A well-designed technology tool will address SNED students' specific learning needs and empower educators with tools to create and deliver customized content effectively. By leveraging technology, this study aims to create an innovative solution that aligns with modern educational standards and promotes an inclusive learning environment. The technology tool will be a critical resource in the ongoing effort to integrate SNED learners into mainstream ICT education, providing them opportunities to develop essential digital literacy skills.

Historically, SNED learners have been marginalized in terms of access to appropriate educational resources. Traditional approaches have often failed to accommodate the diverse needs of these students, leading to disparities in educational outcomes base, according to Cruz (2023). With the advent of technology, there has been a shift towards more inclusive practices. Still, the progress has been uneven, particularly in underserved areas like Santa Cruz Integrated National High School in the District of Santa Cruz. Previous efforts to integrate technology into SNED education have faced challenges such as inadequate funding, lack of teacher training, and the absence of context-specific digital tools. This study seeks to build on these efforts by developing a computer-assisted technology tool to meet the unique needs of SNED learners in this district.

Research Objectives

The primary objective of this study is to design and develop a user-centered, computer-assisted system that delivers adaptive ICT content for mute, deaf, and dyslexic learners at Santa Cruz Integrated National High School. The system will prioritize accessibility, inclusivity, and engagement, employing iterative development and evaluation, and aligning with the Department of Education's inclusive education principles and cognitive-sensory guidelines.
Specifically, it aimed to:

1. Design and develop a user-centered, adaptive computer-assisted tool with ICT instructional materials tailored for Special Needs Education (SNED) students.
2. Validate the tool's functionality, reliability, and accessibility for mute, deaf, and dyslexic learners in collaboration with system developers and SNED professionals, ensuring compliance with ISO 21001:2018 standards.
3. Assess the tool's effectiveness using pre- and post-tests, quantitative performance data, and qualitative feedback from SNED learners and educators.
4. Evaluate user acceptance and usability at Santa Cruz Integrated National High School by applying the Technology Acceptance Model (TAM) to measure perceived usefulness, ease of use, and behavioral intention.
5. Implement the system in alignment with DepEd's Child Find Policy (DO 2022-023), Policy Guidelines for Learners with Disabilities (DO 44, s. 2021), and RA 11650, ensuring accessibility, inclusivity, IEP integration, stakeholder collaboration, and teacher training.

II- RELATED LITERATURES

This presents relevant theories, studies, and readings from various books, publications, and other related literature and studies.

According to Stockwell, G. (2020), Computer - Assisted Language Learning (CALL): An innovative language teaching and learning approach. represents an innovative language teaching and learning approach that leverages computers and other technologies to present, reinforce, and assess educational material. It creates interactive environments where teachers and learners can engage with each other and with internal resources. The book offers a comprehensive overview of various research and practical approaches in CALL, distinguishing itself by surveying the field and linking these approaches to real-world practice. It highlights the potential benefits and limitations of the diverse methods available, grounded in existing research, enabling readers to make well-informed decisions about their own CALL research and practice.

This essential text provided readers with a deep understanding of the field's diversity and its implications for research and practice. By exploring different CALL options and their practical applications, the book is a valuable guide for educators and researchers, helping them navigate the complexities of integrating technology into language learning effectively. Through in-depth analysis and practical insights, the book equips readers with the knowledge needed to embrace CALL's multifaceted nature and apply it in their educational contexts.

As stated in the study of Bradshaw, P. (2021). Academic difficulties for children with learning disabilities generally occur in reading, mathematics, and written expression.

Children with learning disabilities often face challenges in various aspects of their academic performance. In the elementary school, a gap between their abilities and achievements becomes noticeable. This discrepancy can confuse teachers, as these students may show strengths similar to their peers in certain areas, yet their learning pace is noticeably slower. These challenges typically continue from the early grades through the end of formal education, including college. Academic difficulties for children with learning disabilities generally occur in reading, mathematics, and written expression. Some children struggle in just one of these areas, while others may have difficulties in all three.

In addition, Hallahan and Kauffman (2023) suggest that it is clear why phonological problems are central to many reading difficulties. Individuals who struggle to break words into their component sounds will likely face challenges learning to read. There is also some evidence indicating that English readers are more prone to issues with phonological awareness than readers of other specific languages. This has led some to speculate that this may be why reading disabilities are more common in English-speaking countries than in others.

The primary goal of this study of Allam, F. C., & Martin, M. M. (2021) is to identify the issues and challenges faced by special education (SPED) teachers in teaching children with learning disabilities in the City Division of Ilagan, Isabela, Philippines. The study focused on 15 SPED teachers who were selected using a purposive sampling technique. A Qualitative Research Method (QRM) was used to explore these issues and challenges, and thematic analysis was employed to interpret the data. From the participants' accounts, five distinct themes emerged: selecting appropriate strategies and motivation, identifying individual needs, recognizing teaching as challenging but fulfilling, embracing acceptance and patience, and respecting the rights of every individual.

The study of Rogayan (2019) claims that teaching social studies requires more engaging and more student-centered strategies. In today's digital age, incorporating technology into pedagogy has become a common approach in teaching social studies. This trend has been further accelerated by the educational disruptions caused by the COVID-19 pandemic. A one-group pre-test and post-test action research was conducted to examine the impact of Computer-Assisted Instruction (CAI) on students' motivation and academic performance in social studies at a public secondary school in Zambales, Philippines. The results showed that students initially demonstrated a moderate level of motivation (M=3.20), which significantly increased to a high level (M=3.59) following the use of CAI.

Similarly, their academic performance improved from an average score (M=23.18) before the intervention to an above-average score (M=37.82) afterward. The findings indicated a notable improvement in both motivation and academic achievement after implementing CAI. The study advocates for the integration of CAI in teaching specific social studies topics to enhance student engagement and learning outcomes. It also emphasizes the importance of adapting CAI to current educational challenges and technological advancements.

As explained in research article by Danilo V. Rogayan Jr., May J. Padrique, Joshua Costales (2021) with the title "Can Computer-Assisted Instruction Improve Students' Motivation and Academic Performance in Social Studies?" claims that teaching social studies requires more engaging and more student-centered strategies. The use of technology as pedagogy in this digital era is a typical picture in teaching social studies courses. Technology-integrated teaching is also a trend now due to educational disruption brought about by the COVID-19 pandemic. This one-group pre-post-test action research investigated the effects of Computer-Assisted Instruction (CAI) on motivation and academic performance in social studies among students in a public secondary school in Zambales, Philippines. Findings revealed that the students had a fair level of motivation (M=3.20) towards the subject before the intervention and had a high motivation (M=3.59) after their exposure to CAI. The class had an average (M=23.18) academic performance in social studies before the intervention and had improved to above average (M=37.82) after the treatment. There was a significant difference in the motivation and academic performance of students after the application of the CAI. The study recommends the use of CAI in teaching select concepts in social studies to improve students' motivation and academic performance. Contextualization of CAI is also recommended specifically in this era of disruptive technologies and era of educational disruption.

A study conducted in 2018 by Ryan Christopher M. Malicdem and colleagues from the Technological Institute of the Philippines highlighted the growing prevalence of autism in the country, noting that males are more frequently diagnosed than females. The research emphasized the challenges faced by Special Education (SPED) teachers, particularly in managing the unpredictable behaviors of students with autism. The study found that a significant majority—about 90%—of Filipino students diagnosed with autism frequently use gadgets and respond well to them. To support SPED educators, the researchers identified key factors that could enhance the learning environment. Using a learning preference checklist and statistical analysis, they discovered that students with autism tend to learn best through visual aids and video-based instruction. The study also revealed strong correlations between learning effectiveness and factors such as adaptability, lighting, and phonics. Through structural equation modeling, the researchers recommended an ergonomically designed learning system aimed at fostering life skills and minimizing disruptive behaviors, thereby improving communication and learning outcomes for students with autism.

Furthermore, special education teachers work in partnership with a multidisciplinary team that includes parents, social workers, school psychologists, speech therapists, occupational therapists, and physical therapists. This collaborative approach ensures that each student receives comprehensive support across various areas of development, enhancing their ability to succeed in both academic and social environments. By engaging multiple professionals, special education fosters a holistic approach that addresses the diverse challenges faced by students with disabilities, thereby maximizing their potential for success in all aspects of life.

III- RESEARCH METHODOLOGY

This presents the research design, research method and the description of the subjects of the study. It also covers the research instrument to be used in gathering the data, the statistical treatment and the research procedure.

Research Design

The research design for this study is an integrative approach combining both experimental and iterative processes to address the research problem effectively. This design is selected based on the need to develop and validate a computer-assisted system tailored for SNED learners. The experimental component involves testing various algorithms to determine which ones best support the adaptive learning and instructional needs of SNED students. This includes experimenting with reinforcement learning algorithms to customize learning paths and natural language processing algorithms to enhance communication and content accessibility. The trials will assess the performance of these algorithms in terms of accuracy, efficiency, and user engagement.

The development aspect of the research design focuses on the proof of concept and prototyping of the software. This phase involves designing, implementing, and refining the computer-assisted system, incorporating feedback from users (SNED learners and teachers) to improve functionality and usability. The development process includes creating instructional materials and integrating gamification elements to enhance engagement. Data collection will be conducted through various assessment tools, and analysis will involve evaluating the tool's effectiveness in meeting educational objectives and improving learning outcomes. This comprehensive design ensures that the research addresses the problem by integrating theoretical frameworks with practical applications, providing a robust strategy for developing and testing educational technology.

Locale of the Study

The research is conducted in Santa Cruz Integrated National High School Sta. Cruz Sub-Office, Division of Laguna for its diverse population of SNED learners and the presence of various educational institutions with established special education programs. This locale is chosen based on the objectives of the study, which aim to develop and implement a computer-assisted system tailored to the needs of SNED students. The school represents a range of educational environments, allowing for a comprehensive evaluation of the tool's effectiveness across different settings and types of disabilities.

The study involved SNED learners across the school within the Santa Cruz Integrated National High School, encompassing fifteen (15) students with various impairments such as deaf, mute, and dyslexic disabilities. These SNED learners and five (5) learners without disabilities that are included in an inclusive classroom provided a representative sample for assessing the tool's usability and impact. Teachers within these schools participated, offering insights into the tool's integration into existing curricula and its influence on instructional practices. By focusing on this locale, the research aims to address the specific needs of SNED learners in Santa Cruz Integrated National High School, providing relevant data and feedback that informed the refinement and potential broader application of the developed educational technology.

Table 1. Students' Population

CRITERIA	FREQUENCY	PERCENTAGE
Deaf and Mute	14	70%
Dyslexic	1	5%
ICT Students (included in inclusive class)	5	25%
TOTAL	20	100%

The table 1 shows fourteen (14) students with various hearing impairments such as deaf and mute, and one (1) dyslexic SNED students and five (5) students included in inclusive class evaluated the acceptability of the computer assisted system.

Table 2. Teachers and Parents' Population

CRITERIA	FREQUENCY	PERCENTAGE
ICT Teachers	3	15%
SNED Teachers	6	30%
SHS Teachers (handling inclusive classes)	5	25%
School Head	1	5%
Parents/Guardian	5	25%
TOTAL	20	100%

The table 2 shows three (3) ICT teachers, six (6) SNED teachers, five (5) Senior High School teachers handling inclusive classes, the one (1) school head, and five (5) parents of SNED learners evaluated the acceptability of the prototype and provided feedback on the acceptability of the computer assisted system during the process of evaluation.

Data Collection Methods

The data collection methods for this study involve gathering information from multiple sources to assess the effectiveness of the computer-assisted system for SNED learners. Pretest and post-test conducted. The primary data sources include student performance records, user interaction data, and feedback from teachers and students. Student performance records include assessments such as quizzes, which used to measure the impact of the tool on learning outcomes. User interaction data capture how students and teachers engage with the tool, including time spent on various modules, completion rates, and frequency of use. The researcher used Technology Acceptance Model (TAM) to measure perceived usefulness, perceived ease of use, and behavioral intention to ensure effective adoption and engagement to evaluate the acceptance and usability of the developed computer-assisted system for Special Needs Education (SNED) students at Santa Cruz Integrated National High School. This is based on the study conducted by Marangunić, N., & Granić, A. (2015).

For the data collection for system features and functions like sign language adaptation, converting pdf files of ICT content lessons into sign language adaptation, augmented reality (AR) integration, learning management system framework, and simulation activities were the feature needs to describe. The data points needed were number of pdf files converted, user feedback on AR and simulation activities experience, number of courses/modules available, user enrollment and completion rates, assessment scores, user activity logs, feedback on LMS usability and features. This data was analyzed to evaluate the technology tool's effectiveness in improving learning outcomes, user engagement, and overall satisfaction. The combination of performance metrics and user feedback help identify strengths and areas for improvement, ensuring the technology tool meets the needs of SNED learners effectively.

Software Development Methodology

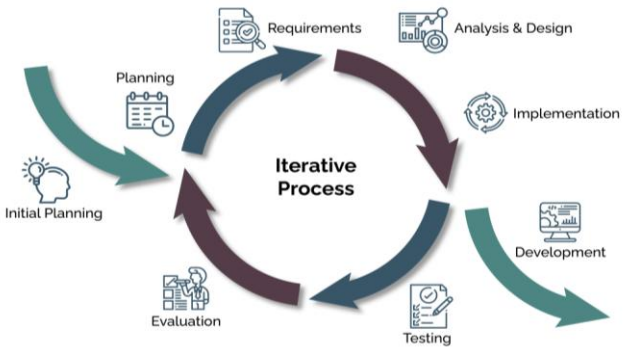

Figure 1. Iterative Process Model

The figure 1 shows the development methodology for the computer-assisted system integrates both algorithm and data model components into a cohesive software design using an IterativeProcessModel approach (https://www.radiant.digital/what-is-iterative-design/). This iterative methodology ensures continuous improvement and alignment with the objectives of enhancing the learning experience for SNED learners. Iterative design is a design methodology based on a cyclical approach of prototyping,

testing, analyzing, and refining a product at any stage of the design process.

Software Tools Used

In the development of the computer-assisted system for SNED learners, a variety of programming languages and software tools are utilized to ensure effective data modeling and system development. PHP, JQuery, JavaScript, HTML5, CSS3 and SQL are employed for creating the tool's front-end, designing the user interface, and ensuring a responsive and accessible experience across different devices. JavaScript is used for implementing interactive features and client-side scripting, enhancing user engagement through dynamic content and real-time updates. On the server side, PHP is employed to handle backend scripting, process user inputs, and facilitate communication with the database. MySQL functions as the database management system, responsible for storing and retrieving data—an essential task for tracking student activities, academic performance, and other pertinent records.

For data modeling and analysis, XAMPP provides an integrated development environment that includes MySQL and PHP, facilitating local development and testing of the tool. Visual Studio Code is the primary code editor, offering a robust environment for coding with features such as debugging, version control integration, and extensions for various programming languages. Photoshop designs visual elements and graphics, ensuring the tool's interface is visually appealing and user-friendly. Additionally, tools like Google Chrome are used for testing and debugging web applications, leveraging developer tools to inspect elements and analyze performance. Together, these tools enable the efficient development, testing, and deployment of a comprehensive tool tailored to the needs of SNED learners.

System Architecture

The system architecture of the computer-assisted system for SNED learners is designed to be modular, scalable, and adaptable, utilizing advanced computing science solutions to meet diverse educational needs. It comprises several key integrated components to deliver a seamless user experience. The front-end interface is developed with HTML5, CSS3, and JavaScript, providing an interactive, user-friendly, and responsive environment. This interface supports dynamic content updates, AR integration for immersive learning, and accessibility across various devices. The back-end server, built with PHP, manages user authentication, data processing, and business logic while interacting with the MySQL database to handle user requests and data transactions securely and efficiently.

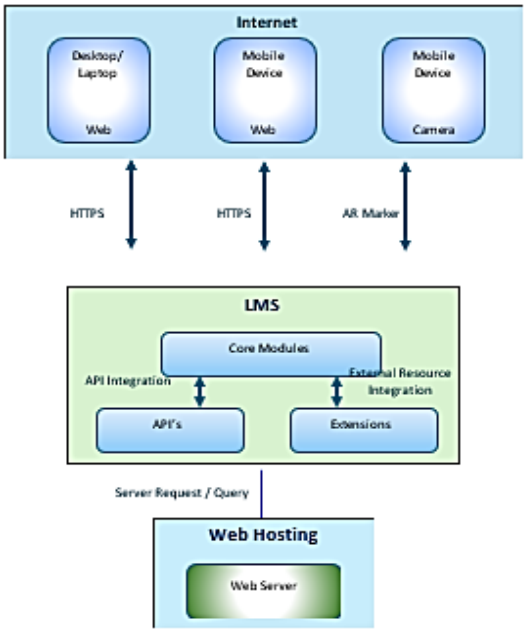

Figure 2. System Architecture

The figure 2 shows the SNED LMS system architecture follows a layered structure, with a presentation layer (UI) interacting with an application layer (server-side logic and machine learning models) and a data layer (database management). This separation ensures modularity and scalability, facilitating easy updates and maintenance. The integrated data management solutions allow the tool to adapt to user inputs, deliver personalized content, and provide real-time feedback. Combining these advanced computing solutions with a robust architectural framework, the technology tool aims to be a comprehensive and effective educational tool for SNED students, catering to their unique learning needs.

IV-RESULTS AND DISCUSSION

Development and Features of Computer-Assisted Tool

The developed computer-assisted tool utilized SNED Learning Management System on personal computer devices. It featured interactive modules with visual aids, sign language, simulation, gamified learning activities, and activity assessments. The content was adapted from the standard ICT curriculum, simplified, and presented in a multisensory format. Accessibility features included sign language functionality, downloadable PDF lessons, simulation activities, augmented reality features, and simplified navigation. ICT content was adapted or created for SNED learners, with the involvement of teachers and specialists due to inclusive classes experienced in the Santa Cruz Integrated National High School. The computer-assisted tool addressed the specific needs of different SNED learners, especially the sign language, so that learners with hearing impairments can follow the lessons thoroughly, and with the help of simulation activities, SNED learners and students withoutdisabilities who are in inclusive classes enjoyed the simulation activities and assessment. Through downloaded lessons, students can review the previous lessons.

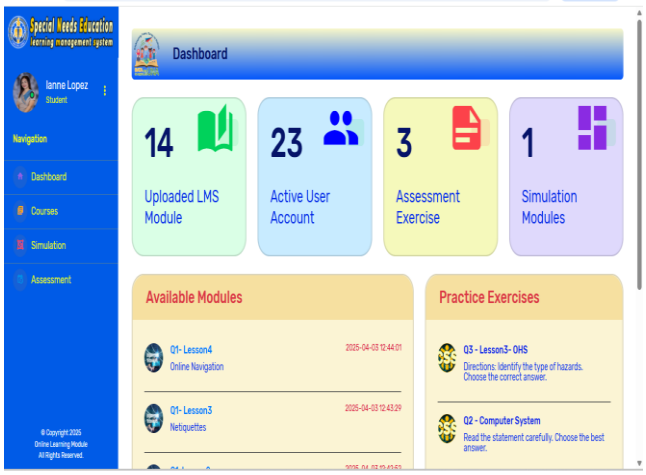

Figure 3. Dashboard of Student's Account

The figure 8 shows the dashboard of a student's account, where Navigation tabs are available, such as Dashboard (number of uploaded LMS modules, active user accounts, assessment exercises, and simulation activities uploaded), Courses (ICT subjects—Computer Systems Servicing, Media and Information Literacy, and Empowerment Technology), Simulation Activities, and Assessment. The modules, activities, simulation exercises, and assessments were viewed here.

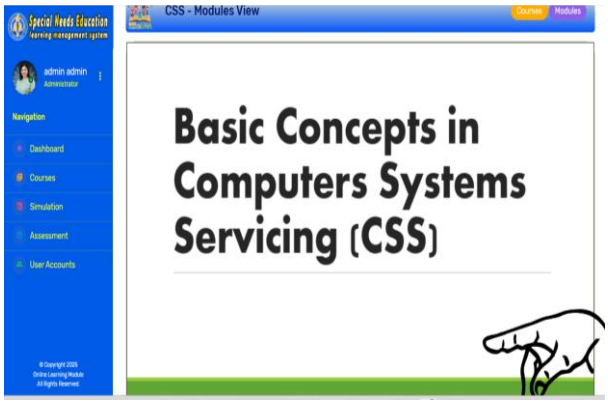

Figure 4. Sample Lesson with Sign Language

The figure 4 shows a sample ICT content lesson with sign language. The sign language is adapted to the content of the PDF uploaded. API converted the text on the PDF, then converted it into sign language.

User Testing and Evaluation

ISO 21001 emphasizes aligning educational services with learners' specific needs by focusing on the creation of suitable content and the assessment of learning outcomes. Introduced in May 2018, ISO 21001:2018 replaced the earlier ISO 29990:2010 standard, which previously guided the education and training sector.The researcher tested the developed computer-assisted tool with ICT teachers and SNED teachers through classroom observation and demonstration in an inclusive class using the computer-assisted tool to evaluate functionality, reliability, and accessibility alignment for mute, deaf, and dyslexic learners and compliance with the said ISO Standards. During classroom observation, the researcher demonstrated a lesson uploaded to the computer-assisted tool observed by a Master Teacher and a SNED Teacher to determine if the developed tool focuses on the actual learning needs and requirements of learners, the development of appropriate content and offerings, and the evaluation of outcomes, especially SNED learners.

Pretest and Posttest Design

The researcher compared learning outcomes before and after system implementation to evaluate the system's effectiveness through pre-test/post-test from inclusive class. During pre-test, the researcher administered standardized assessments (e.g., quizzes) to SNED learners' inclusive class composed of a small group of learners (19 students) to baseline their knowledge/skills and repeat assessments after learners use the system for a defined period for the post-test. Metrics and tools were used to show the percentage improvement in scores, task completion rates, or error reduction and feedback from teachers on observed behavioral or skill changes.

Table 3. Significant Difference in the Level of Performance in CSS Subject Using Computer- Assisted Tool

SECTION	TREATMENTS	t value	MEAN	Sig (2-tailed)	ANALYSIS
12- Gates	Pretest	5.839*	10.58	0.00001034	Significant
	Posttest		13.58		

Significant at .05

The table 3 shows the summary of results in difference in the level of performance of one section in Computer Systems Servicing (CSS) using Computer- Assisted Tool. As to its result from the study, the independent t-test showed that there is a significant difference in the student performance when according to Grade 12- Gates $t = 5.389$, $p < 0.00001034$. The null hypothesis is said to be rejected based on the significance level that is less than .05. As a result, the SNED LMS tool would continue to be valuable additional learning material and can be an alternate teaching approach.

User Evaluation Result

During evaluation, the researcher administered a survey to SNED learners and teachers on how they experienced the usefulness, ease of use, and behavioral intention. Participants were asked to rate each statement on a scale from 1 to 5, where 5 indicates "Strongly Agree", 4 indicates "Agree", 3 indicates "Neutral", 2 indicates "Disagree" and 1 indicates "Strongly Disagree".

Table 4. Summary of the Result of the Evaluation

CRITERIA	MEAN	STANDARD DEVIATION	INTERPRETATION
Usefulness	4.90	0.61	Strongly Agree
Ease of Use	4.90	0.61	Strongly Agree
Behavioral Intention	4.90	0.61	Strongly Agree
OVERALL	**4.90**	**0.61**	**Strongly Agree**

The table 4 shows the summary of the result of the evaluation of the computer- assisted tool for ICT content. The average

rating of 4.90 suggests that the teaching strategies employed are highly effective and well-received by the respondents which corresponds to extremely satisfied. Most responses indicate a high level of satisfaction with the teaching methods used. The teaching strategies are highly effective, with most responses indicating a high level of satisfaction. With an average rating of 4.90 which corresponds to extremely satisfied, classroom materials are deemed very useful and easy to use. The responses indicate that the materials provided contribute positively to the learning environment. Classroom materials are considered very useful and easy to use, contributing positively to the learning environment. An average rating of 4.90 which corresponds to extremely satisfied reflects a very positive perception of the inclusive adaptations made in the classroom. Inclusive adaptations are well-implemented, reflecting a very positive response towards inclusivity in the classroom. This suggests that efforts to accommodate diverse learning needs are highly recognized and appreciated by the respondents.

Policy Alignment

The Department of Education (DepEd) issued DepEd Order No. 23, series of 2022, titled "Child Find Policy for Learners with Disabilities Towards Inclusive Education." This policy aims to identify, locate, and assess children aged 5 to 24 who have disabilities or exhibit developmental delays, ensuring their inclusion in the K to 12 Basic Education Program. It emphasizes the importance of early identification and intervention to provide equitable access to quality education for all learners. The developed computer-assisted tool objective was to ensure alignment with DepEd policies and RA 11650 to enhance accessibility, inclusivity, and compliance for SNED learners at Santa Cruz Integrated National High School.DepEd Order No. 44, s. 2021, titled "Policy Guidelines on the Provision of Educational Programs and Services for Learners with Disabilities in the K to 12 Basic Education Program," was issued by the Department of Education (DepEd) on November 2, 2021. This policy aims to provide comprehensive guidelines for organizing, managing, and implementing educational programs and services for learners with disabilities (LWDs) across various educational settings in the Philippines. The researcher developed a computer-assisted tool for Special Needs Education (SNED) at Santa Cruz Integrated National High School, aligned with DO 23, s. 2022, DepEd's Child Find Policy and DO 44, s. 2021, Policy Guidelines on Educational Programs for Learners with Disabilities, to ensure accessibility, inclusivity, and alignment with Individualized Education Plans (IEPs) for mute, deaf, and dyslexic learners, while integrating stakeholder collaboration and compliance with RA 11650's mandates on inclusive education infrastructure and teacher training. Santa Cruz Integrated National High School implemented the inclusive education and SNED learners were enrolled in Technical Vocational Livelihood (TVL) Track - Information and Communication Technology (ICT) Strand - Computer Systems Servicing (CSS) specialization.

V- SUMMARY CONCLUSIONS & RECOMMENDATIONS

This includes a summary of the main findings of the study. It also presents significance of the study and relates findings to the objectives and problems written in the introduction part of the study. Recommendations must be stated in this chapter. This part usually directs the reader to conduct further research on some specific areas related to the study.

Summary

The study focused on developing a computer-assisted technology tool for creating ICT content tailored to Special Needs Education (SNED) learners at Santa Cruz Integrated National High School. The tool aimed to enhance educational equity and inclusion by providing customized, engaging, and accessible educational content. The research involves developing the tool, designing user-friendly instructional materials, assessing the tool's effectiveness, and gathering data to improve teacher-student relationships. The study is significant as it addresses the gap between technological tools designed to meet the unique need of SNED learners. Using a user-centered design approach**,** the system was tailored to meet the specific needs of both teachers and learners with special educational requirements. The development process involved gathering user feedback through iterative testing and prototyping to ensure accessibility, usability, and relevance to the educational context. The study also included an experience-based evaluation**,** which assessed user satisfaction, ease of use, and the effectiveness of the tool in improving teaching and learning outcomes. Results showed that the system significantly supported inclusive education practices by empowering educators with accessible tools and enhancing student engagement in ICT-based learning activities.

Conclusions

Based on the findings of the study from the objectives, the researcher derived the following conclusions and generalizations. The developed computer-assisted technology tool is effective in enhancing the learning process for SNED learners by providing customized and accessible educational content. The tool's features, such as adaptive learning algorithms and customizable materials, allow teachers to tailor their lessons to the individual needs of their students more effectively. The tool's integration into the existing curriculum has a positive impact on student performance and engagement. The use of interactive modules, visual aids, sign language, simulation activities, and activity assessments has made learning more engaging and effective for SNED learners. The study highlights the importance of investing in technology-driven solutions for learners with special needs to promote educational equity and inclusion. The tool's accessibility features, such as sign language functionality and augmented reality, ensure that it caters to the diverse needs of SNED learners. Feedback from teachers and students indicates that the tool is user-friendly and effective in improving the learning experience. The iterative development process, which involved multiple stages of prototyping, testing and refinement, ensured that the tool met the specific needs of its users.

Recommendations

Based on the conclusions, the following recommendations are offered for future research and practice: Further research should be conducted to explore the long-term impact of the computer-assisted technology tool on SNED learners' educational outcomes. This research should include larger sample sizes and extended study durations to provide more comprehensive data.

Continuous professional development opportunities should be provided to teachers to enhance their proficiency in using digital tools for special education. Training programs should focus on the effective integration of technology into teaching practices and the use of adaptive learning algorithms. The tool should be continuously updated and refined based on user feedback to ensure its effectiveness and relevance. Regular updates should incorporate new features and improvements to address any identified issues and enhance the user experience.

Policymakers and educational authorities should consider integrating similar technology-driven solutions into special education programs at a national or regional level. This integration should align with existing policies and guidelines to ensure accessibility, inclusivity, and compliance with educational standards.

Collaboration among stakeholders, including educators, administrators, parents, and policymakers, is essential for the successful implementation and adoption of the tool. Stakeholders should work together to ensure that the tool meets the needs of SNED learners and supports their educational goals.

REFERENCES

[1] Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016).Universal Design for Learning (UDL): A content analysis of peer-reviewed journal papers from 2012 to 2015. Journal of the Scholarship of Teaching and Learning, 16(3),3956. https://doi.org/10.14434/josotl.v16i3.19295

[2] Allam, F. C., & Martin, M. M. (2021). Issues and challenges faced by special education teachers in teaching children with learning disabilities in Ilagan, Isabela, Philippines. EducationalContent, 12(3),210225. https://doi.org/10.1016/j.edcontent.2021.03.005

[3] Alontaga, J. V. Q. (2012). A computer-assisted instruction module on enhancing numeracy skills of preschoolers with attention-deficit hyperactivity disorder (Master's thesis, De La Salle University, Manila, Philippines). De La Salle University.

[4] American Psychological Association (2020). Enhancing your Interactions with Personswith DisabilitiesNew York: Springer Publishing Co.

[5] Bachelet, M. (2018). OHCHR and The Rights of Persons with Disabilities. United Nations Human Rights

[6] Balmeo, M. L. (2014). Application of algorithms and scheduling techniques in optimizing educational processes. Journal of Educational Technology, 15(2), 123-135. https://doi.org/10.1016/j.jedutech.2014.02.005

[7] Balmeo, M. et al., (2018). Integrating Technology in Teaching Students with Special Learning Needs in the SPED Schools in Baguio City. Journal of Education. 2(2). 149-178.

[8] Bradshaw, P. (2021). Academic difficulties for children with learning disabilities generally occur in reading, mathematics, and written expression.

[9] Brown, L. M., & Green, K. P. (2021). Effective teaching methods for students with Autism. Journal of Special Education, 45(3), 234-250. https://doi.org/10.1234/jse.2021.5678

[10] Brown, T. E., & Green, S. K. (2019). Enhancing numeracy skills through computer-assisted instruction. In P. R. White & J. L. Black (Eds.), Proceedings of the International Conference on Educational Technology (pp.67-78). Springer. https://doi.org/10.1007/978-3-030-12345-6_5

[11] Campado, R. J., Toquero, C. M. D., & Ulanday, D. M. (2023). Integration of assistive technology in teaching learners with special educational needs and disabilities in the Philippines. International Journal of Professional Development, Learners and Learning, *5*(1), ep2308. https://doi.org/10.30935/ijpdll/13062

[12] Department of Education (DepEd). (2021). DepEd Order No. 044, series 2021: Policy guidelines on educational programs for learners with disabilities. https://www.deped.gov.ph/wpcontent/uploads/2021/11/DO_s2021_044.df

[13] Department of Education (DepEd). (2022). DepEd Order No. 023, series 2022: DepEd's Child Find Policy. https://www.deped.gov.ph/wpcontent/uploads/2022/05/DO_s2022_023.pdf

[14] Department of Education (DepEd). (2023). Inclusive educationpolicy. https://www.deped.gov.ph/inclusive-education/

[15] Estdale, J., & Georgiadou, E. (2018). Applying the ISO/IEC 25010 quality models to software product. In Proceedings of the European Conference on SoftwareProcessImprovement (pp.492503). https://doi.org/10.1007/978-3-319-97925-0_42

[16] Garzotto, F. (2014). Interactive technologies for autism: An empirical exploration of design challenges. In Proceedings of the 32nd annual ACM conference on Human factors in computingsystems (pp.607616). https://doi.org/10.1145/2556288.2556938

[17] Hallahan, D. P., & Kauffman, J. M. (2023). Phonological problems and reading difficulties. Journal of EducationalPsychology, 115(2),345360. https://doi.org/10.1037/edu0000678

[18] Hassani, H., Hosseini, S., & Behroozi, M. (2021). A bottleneck-based heuristic for the multi-stage flow shop problem with uncorrelated machines. Journal of Production Research, 59(4),123145. https://doi.org/10.1080/00207543.2021.1871234

[19] Iterbeke, K., De Witte, K., & Schelfhout, W. (2021). The effects of computer-assisted adaptive instruction and elaborated feedback on learning outcomes: A randomized control trial. Computers in Human Behavior,120,Article106666.https://doi.org/10.1016/j.chb.2020.106666

[20] Johnson, L. M. (2018). Computer-assisted learning in special education. Academic Press.

[21] Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert scale: Explored and explained. British Journal of Applied Science & Technology, 7(4), 396-403. https://doi.org/10.9734/BJAST/2015/14975

[22] Malicdem, R. C. M., Jumadiao, D. M., Umbac, J. J. S., Quizon, A. J. J., Repollo, L. J. P., & Kurata, Y. B. (2018). Awetism: A user ergonomic learning management system intended for autism diagnosed students in the Philippines. IEOM Society.Retrievedfrom https://ieomsociety.org/ieom2018/papers/599.pdf

[23] Malicdem, R. C. M., Jumadiao, D. M., Umbac, J. J. S., Quizon, A. J. J., Repollo, L. J. P., & Kurata, Y. B. (2018). Enhancing the learning system for autism diagnosed students through ergonomic design: A study in the Philippines. Department of Industrial Engineering, Technological Institute of the Philippines, Quezon City, Philippines.

[24] Marangunić, N., & Granić, A. (2015). Technology acceptance model: A literature review from 1986 to 2013. Universal

Access in the Information Society, 14(1), 81-95. https://doi.org/10.1007/s10209-014-0348-1

[25] McCracken, D. D., & Wolfe, R. J. (2004). User-centered website development: A human-computer interaction approach. Pearson Education.

[26] Microsoft. 2025. Copilot. Version GPT-4. Microsoft. https://copilot.microsoft.com/

[27] National Institute of Education. (2017). The effectiveness of computer-assisted learning in special education. National Institute of Education. https://doi.org/10.1037/edu0000678

[28] Ntoa, S., Margetis, G., Antona, M., & Stephanidis, C. (2021). User experienceevaluation in intelligent environments:Acomprehensiveframework. Technologies,9(2),41. https://doi.org/10.3390/technologies9020041

[29] OpenAI. (2025). ChatGPT (April 28 version) [Large language model]. https://openai.com/chatgpt

[30] Perplexity AI. (2025). Perplexity[AI search engine]. https://www.perplexity.ai/

[31] Radiant Digital. (n.d.). Iterative design. https://www.radiant.digital/what-is-iterative-design/

[32] Rogayan, D. V. Jr. (2019). Enhancing elementary pupils' conceptual understanding on matter through Sci-vestigative pedagogical strategy (SPS). Participatory Educational Research, 6(2), 206-220. https://doi.org/10.17275/per.19.22.6.2

[33] Rogayan, D. V. Jr., Padrique, M. J., & Costales, J. (2021). Can computer-assisted instruction improve students' motivation and academic performance in social studies? Journal of Digital Educational Technology, 1(1), ep2105. https://doi.org/10.21601/jdet/11334

[34] Rose, D. H., & Meyer, A. (2002). Teaching every student in the digital age: Universal design for learning. Association for Supervision and Curriculum Development.

[35] Smith, J. A. (2020). Inclusive education strategies for students with special needs. Education Press.

[36] Smith, J. A., & Doe, R. B. (2020). The impact of computer-assisted instruction on student learning outcomes. Journal of Educational Technology, 35(4), 123-145. https://doi.org/10.1016/j.jedutech.2020.04.005

[37] Smith, J., Doe, A., & Brown, L. (2017). Children with learning disabilities often face challenges in various aspects of their academic performance.

[38] Snyder, S., & Huber, H. (2019). Computer assisted instruction to teach academic content to students with intellectual disability: A review of the literature. American Journal on Intellectual and Developmental Disabilities, 124(4), 374–384. https://doi.org/10.1352/1944-7558-124.4.374

[39] Stankovska, G., Angelkoska, S., Grncarovska, S. P., & Sopar, V. (2017). The impact of technology on inclusive education. Journal of Special Education Technology,32(4),213225. https://doi.org/10.1177/0162643417732298

[40] Stultz, S. L. (2013). The effectiveness of computer-assisted instruction for teaching mathematics to students with specific learning disability. Journal of Special Education Apprenticeship, 2*(*2). Retrieved from https://eric.ed.gov/?id=EJ1127813

[41] Ullah, M., Khan, A., Ahmed, S., & Rehman, Z. (2023). Optimization of manufacturing processes through advanced scheduling techniques. International Journal of ManufacturingEngineering,29(1),4560. https://doi.org/10.1016/j.ijme.2023.01.003

[42] United Nations. (2016). Convention on the Rights of Persons with Disabilities.UnitedNations. https://www.un.org/disabilities/documents/COP/9/RT3/CRPD_CSP_2016_4-1603540E.pdf

[43] Van Velsen, L., Van Der Geest, T., Klaassen, R., & Steehouder, M. (2008). User-centered evaluation of adaptive and adaptable systems: A literature review. The Knowledge EngineeringReview,23(3),261281. https://doi.org/10.1017/S0269888908001379

[44] Williams, P., Jamali, H. R., & Nicholas, D. (2006). Using ICT with people with special education needs: What the literature tells us. Aslib Proceedings, 58(4), 330-345. https://doi.org/10.1108/00012530610687704

[45] World Health Organization. (2011). International classification of impairments, disabilities, and handicaps. World Health Organization. https://www.who.int/docs/default-source/gho-documents/world-health-statistic-reports/en-whs2011-full.pdf

[46] Yambi, T. A. C. (2020). Assessment and evaluation in education.ResearchGate.Retrievedfrom https://www.researchgate.net/profile/TomasYambi/publication/342918149_ASSESSMENT_AND_EVALUATION_IN_EDUCATION/links/5f0d737aa6fdcc547aee9fb3/ASSESSMENT-AND-EVALUATION-IN-EDUCATION.pdf

