EdinBurg Peer Reviewed Journals and Books Publishers
Journal of Information and Technology
Vol. 5||Issue 3||pp 43-57||June||2025
Email: info@edinburgjournals.org||ISSN: 3080-9576

Enhancing Inclusive Education: The Impact of an Al-Integrated E-Learning Platform (Moodle) For Deaf and Hard-of-Hearing Students in Rwanda's Secondary Schools

Nyituriki Mateme Prosper[1*] & KN Jonathan[2]
[1,2]Faculty of Computing and Information Sciences, University of Lay Adventist of Kigali (UNILAK)
Corresponding Email: matemeprosper97@gmail.com; phialn1@gmail.com

Accepted: 13 May 2025 || Published: 06 June 2025

Abstract

This research explores the development and implementation of an Al-integrated e-learning platform (Moodle) designed to enhance inclusive education for deaf and hard-of-hearing students in Rwanda's secondary schools. Despite Rwanda's commitment to inclusive education, significant gaps remain in providing accessible education for students with hearing impairments, including insufficient specialized schools and a shortage of sign language interpreters. The study proposes a hybrid solution combining web-based and embedded systems to bridge these communication gaps. The Al-powered platform, dubbed "D-Moodle," translates spoken language into subtitles and sign language using avatar-based technology, providing real-time accessible educational content. Through a mixed-methods approach incorporating surveys, interviews, and observations across selected schools including Hope TSS, Nyabihu School for Deaf, and GS Gitebe, the research evaluates the effectiveness of the proposed platform. Findings indicate that the platform significantly enhances learning experiences by addressing key barriers such as the scarcity of trained sign language interpreters and limited access to digital resources. The system demonstrates positive impacts on student engagement, communication, and academic performance while reducing the socioeconomic burden associated with specialized education. Content adaptation strategies, focusing on multimedia integration, interactive learning activities, and personalized learning pathways. The research concludes that Al-integrated e learning significantly improves educational accessibility for students with hearing impairments, contributing to Rwanda's inclusive education goals. Recommendations include continued investment in assistive technologies, teacher training, and infrastructure development to fully integrate digital solutions into Rwanda's education system.

Keywords: *Inclusive education, deaf education, e-learning, artificial intelligence, sign language translation, accessibility, Moodie, Rwanda*

How to Cite: Prosper, N. M., & Jonathan, K. N. (2025). Enhancing Inclusive Education: The Impact of an Al-Integrated E-Learning Platform (Moodle) For Deaf and Hard-of-Hearing Students in Rwanda's Secondary Schools. *Journal of Information and Technology, 5*(3), 43-57.

1. Introduction

Education is widely recognized as a fundamental right for all individuals, yet students with disabilities, particularly those who are deaf or hard-of-hearing (HoH), continue to face significant barriers to accessing quality education. In Rwanda, the government has made considerable strides toward inclusive education, but gaps remain in providing equitable access to learning resources and opportunities for students with hearing impairments.

According to Rwanda's Ministry of Education (MINEDUC) 2021/22 Education Statistical Yearbook, there are 3,645 students with hearing disabilities enrolled in Rwanda's secondary schools, comprising 2,120 males and 1,525 females. Despite Rwanda's commitment to inclusive education, these students face substantial challenges in their educational journey. The country has 1,955 secondary schools, yet only seven offer specialized programs for deaf and hard-of-hearing students. Furthermore, out of 33,641 secondary school teachers nationwide, only 694 have been trained in sign language, indicating a critical shortage of qualified educators capable of addressing the needs of students with hearing impairments.

This research addresses these challenges by proposing the development and implementation of an Al-integrated e-learning platform based on Moodle (Modular Object-Oriented Dynamic Learning Environment). The platform, referred to as "D-Moodle" (Deaf Moodle), aims to bridge communication gaps and enhance accessibility for deaf and hardof-hearing students in Rwanda's secondary schools. By leveraging artificial intelligence, the platform translates spoken language into text and subsequently into sign language using avatar technology, enabling students with hearing impairments to access educational content more effectively.

The genesis of this research stems from the researcher's personal experience as a teacher at Ecole Secondaire Baptiste de la Fraternite (ESBF), where a student named TUYIZERE with a hearing disability faced significant learning challenges. This experience highlighted the urgent need for innovative solutions to support students with hearing impairments in Rwanda's education system.

The proposed D-Moodle platform addresses several critical issues in the current inclusive education system, including the insufficient number of specialized schools, the limited availability of sign language interpreters (particularly in rural areas), and the restricted educational options available to students with hearing impairments. By developing a hybrid system that combines web-based and mobile technology, the research aims to create a more accessible, flexible, and inclusive learning environment for deaf and hard-of-hearing students in Rwanda's secondary education sector.

2. Literature Review

2.1 Inclusive Education and E-Learning

Inclusive education represents a fundamental shift in educational paradigms, promoting the integration of all learners regardless of their physical or cognitive differences. As defined by UNESCO (2018), inclusive education means "all children in the same classrooms, in the same schools," emphasizing real learning opportunities for traditionally excluded groups, including children with disabilities and speakers of minority languages. This approach aligns with the

broader concept of education as "a purposeful activity aimed at achieving goals like the transmission of knowledge, skills, and character traits" (UNESCO, 2018).

E-learning has emerged as a powerful tool for advancing inclusive education globally. Nichols (2007) defines e-learning as "a learning environment which uses information and communication technologies (ICT's) as a platform for teaching and learning activities," or more concisely, "pedagogy empowered by digital technology." The flexibility, accessibility, and adaptability of e-learning platforms make them particularly valuable for students with disabilities, including those who are deaf or hard-of-hearing.

Moodie, a widely used Learning Management System (LMS), differs from traditional Content Management Systems (CMS) in that it allows direct participant access and interaction. According to Palinscar (1998), Moodie is not merely a content listing system but a learning system that enables participants to learn through interaction, based on the principles of social constructivism. This framework aligns well with the educational needs of deaf and hard-of-hearing students, who may benefit from visual and interactive learning approaches.

2.2 Deaf Education and Technology

Sign languages, as defined by Sandler and Lillo-Martin (2006), are "languages that use the visual-manual modality to convey meaning, instead of spoken words." Sign languages are expressed through manual articulations combined with non-manual markers and representsign language serves as the primary communication mode for deaf students, making its integration into e-learning platforms crucial for accessibility.

Research by Redhuan Samsudin and Rushana Sulaiman (2020) indicates that mobile applications can serve as effective tools for deaf students to study and practice sign language. These findings suggest that digital platforms like Moodie can be adapted to help deaf students practice sign language in international languages such as English and French, enhancing their communication abilities and educational opportunities.

2.3 Artificial Intelligence in Inclusive Education

The integration of artificial intelligence into e-learning platforms represents a significant advancement in inclusive education. Al technologies, including natural language processing, speech recognition, and computer vision, can transform educational content into accessible formats for students with disabilities.

Katzer and Elran (2012) explored learning and teaching with Moodie-based e-learning environments, combining learning skills and content in mathematics, science, and technology. Their work demonstrates how Al-enhanced e-learning platforms can address diverse learning needs and provide personalized educational experiences.

Oyelere et al. (2018) further highlight the potential of Al in enhancing computing education through mobile learning applications. Their research emphasizes the importance of designing, developing, and evaluating mobile learning applications that can support diverse learners, including those with disabilities.

2.4 Conceptual Framework

The conceptual framework for this research integrates multiple theoretical perspectives, including social constructivism, multi-representational learning, and universal design for learning. Drawing on Ainsworth's (2006) multi-representational design model, the framework emphasizes the importance of providing educational content in various formats to accommodate diverse learning styles and needs.

The framework also incorporates Murphy's (1997) constructivist-based pedagogical model, which sets criteria for online courses to adhere to. This model emphasizes problemsolving, higher-order thinking skills, and deep understanding, focusing on conceptual comprehension rather than merely following procedural steps.

Gagne's (1985) nine instructional events further inform the framework, providing a structured approach to designing learning experiences that engage students, facilitate knowledge acquisition, and promote application and transfer of learning.

3. Materials and Methods

3.1 Research Paradigm and Design

This study employs a mixed-methods approach, integrating both qualitative and quantitative research paradigms to provide a comprehensive understanding of the impact of an Al-integrated e-learning platform on deaf and hard-of-hearing students in Rwanda's secondary schools.

Qualitative research, as defined by Denzin and Lincoln (2000), is "a situated activity that locates the observer in the world" and consists of "interpretive, material practices that makes the world visible." This approach enables the researcher to study phenomena in their natural settings and interpret them based on the meanings people bring to them. In this study, qualitative methods were used to explore the experiences, perceptions, and behaviors of students, teachers, and administrators regarding the implementation of the DMoodle platform.

Quantitative research, according to Neuman (2000), aims to develop generalized findings that enable researchers to control, predict, comprehend, and explain phenomena in their natural environments. This approach emphasizes objectivity and the generation of replicable results. In this study, quantitative methods were used to collect and analyze numerical data related to user engagement, academic performance, and system functionality.

The research is characterized as evaluation research or formative research, falling under the broader category of development or design research (Van den Akker, 1999; Bakker, 2004). This approach regards design as the focal point of research, with the aim of informing the development of online learning programs for deaf and hard-of-hearing students in Rwanda's secondary schools.

3.2 Sampling Method and Participants

The study employed purposive sampling to select participants from three secondary schools in Rwanda: Hope Technical Secondary School (TSS), Nyabihu School for Deaf, and GS Gitebe. These schools were chosen based on their involvement in educating deaf and hard-of-hearing

students and their representation of different types of educational institutions (technical, specialized, and general education).

A sample size of 20 participants was determined using quantitative sampling formulas with a confidence level of 90% (Z=0.90), proportion of 50% (P=0.5), and margin of error of 10% (D=0.1). The sample included 12 deaf students who were born deaf and required full translation support, and 8 hard-of-hearing students who developed hearing impairments from other causes and used supporting devices. The participants came from diverse backgrounds and were randomly selected across all grades.

3.3 Data Collection Methods

Multiple data collection methods were employed to gather comprehensive information about the implementation and impact of the D-Moodle platform:

1. *Surveys:* Developed based on established accessibility guidelines, focusing on usability, effectiveness, and satisfaction with e-learning platforms.
2. *Semi-structured interviews:* Conducted with students, teachers, and administrators to gather in-depth insights about their experiences with the D-Moodle platform. Sign language interpreters were used when necessary to facilitate communication with deaf participants.
3. *Observation:* Used to collect data on student engagement, participation, and interaction with e-learning materials. The researcher observed how students navigated the platform, interacted with content, and engaged in learning activities.
4. *Questionnaires:* Deployed to collect information about attitudes, experiences, and opinions regarding the D-Moodle platform. Questionnaires included both open-ended and closed-ended questions to gather diverse perspectives.

3.4 Software Development Methodology

The research employed two software development methodologies: the Waterfall model and the Agile methodology.

The Waterfall model, characterized by a linear sequential approach where each phase depends on the deliverables of the previous one, was initially used to establish the foundational structure of the D-Moodle platform. This model includes several phases: requirement gathering and analysis, system design, implementation, integration and testing, deployment/verification, and maintenance.

However, the primary development methodology used was Agile, which emphasizes flexibility, adaptability, and user-centered design. Agile prioritizes customer collaboration over contract negotiation and responding to change over following a fixed plan. This methodology was selected due to its suitability for developing an AI-integrated e-learning platform for deaf and hard-of-hearing students. Agile's emphasis on flexibility, continuous feedback, and incremental delivery aligns well with the unique needs of inclusive education and the complexity of integrating AI-based sign language translation and accessibility features.

The research employed two software development methodologies: the Waterfall model and the Agile methodology.

The Waterfall model, characterized by a linear sequential approach where each phase depends on the deliverables of the previous one, was used initially to establish the foundational structure of the D-Moodle platform.

This model includes several phases: Requirement Gathering and Analysis, System Design, Implementation, Integration and Testing, Deployment/Verification, and Maintenance.

However, the primary development methodology was Agile, which emphasizes flexibility, adaptability, and user-centered design. The Agile approach prioritizes:

1. Working software instead of comprehensive documentation
2. Customer collaboration over contract negotiation
3. Responding to change over following the plan

Agile was selected as the primary methodology due to its suitability for the development of methodology's emphasis on flexibility, continuous feedback, and incremental delivery aligns well with the unique needs of inclusive education and the complexity of integrating Al-based sign language translation and accessibility features.

3.5. Data Analysis

Data analysis involved a systematic approach to processing and interpreting both qualitative and quantitative data. The analysis process include:

1. Task based analysis: Collecting and analyzing field notes, interviews and analysis of Moodle features, using Microsoft Word and LibreOffice Writter.
2. Data coding: Testing units and features of the Moodle platform, designing themes adding categories and sub categories and developing the D-Moodle platform.
3. System Testing: Assigning the system to learners and teachers for testing in real word education settings.
4. Evaluation and Interpretation: Verifying and recording the system results in comparison to the current running Moodle.

3.6. Ethical Consideration

- ***Informed consent:*** Obtain consent from participants prior to data collection. Here in collecting data to the sampled people, they have given a researcher the information without forcing or torturing. It means that all information basing in this research are provided, with conscience and freedom of speech.
- ***Confidentiality***: Ensure anonymity and confidentiality of participant information, in this case the deaf-mute students. Researcher respect to keep the confidentiality of the sampled people, as well as of those who are regarded to this research, except for those who wish to.
- ***Accessibility***: Ensure all research materials and platforms are accessible to deaf-mute participants. Regarding to this point, the researcher believes that every one of the

participants will be supported in having the needed materials and training if the system implemented.

4. Results and Discussion

4.1. Evaluation of Current running Moodle features

Based on the information available, it seems that the usage of Moodle in Rwanda's secondary schools is still in its early stages. There are some key points:

- **Internet Connectivity**: About 47% of secondary schools in Rwanda have internet connectivity, which is essential for using platforms like Moodle
- **Teacher Training**: Many teachers have received training in ICT and are becoming more comfortable with using digital tools. However, there is still a need for more comprehensive training specifically focused on Moodle.
- **Student Exposure**: Students are gradually being exposed to computer labs and digital learning tools, but there is room for more widespread adoption and integration into the curriculum.
- **E-Learning Initiatives**: Rwanda has launched several e-learning initiatives, such as the "e-School Rwanda" project, which provides digital access to educational resources. This indicates a growing interest in leveraging technology for education.

Overall, while there is progress, there is still significant potential for expanding the use of Moodle and other e-learning platforms in Rwanda's secondary schools.

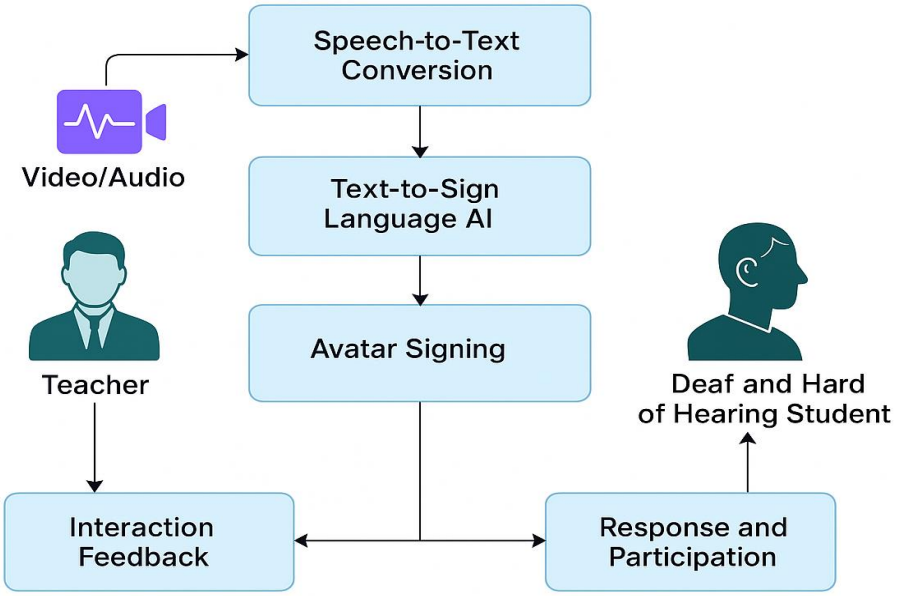
4.2. Implementation of D-Moodle Using Agile Methodology

- **Agile Prioritizes Flexibility and Adaptability**
  One of the core reasons Agile is suitable for developing the AI-integrated Moodle platform is its iterative and incremental approach.
- **Enhanced User Involvement and Feedback Integration**
  Your research highlights the need to accommodate students with deaf and hard-of-hearing disabilities by developing an interactive, AI-assisted Moodle platform. Agile development involves stakeholders (teachers, students, and educational policymakers) at every stage, ensuring that the final product meets their specific needs.
- **Faster Time-to-Market with Incremental Delivery**
  Agile promotes incremental development, meaning the e-learning platform can be deployed in phases rather than waiting for the entire project to be completed.
- **Effective Handling of Changing Requirements**
  As noted in your research, inclusive education policies and technological advancements evolve constantly.
- **Improved Collaboration between Developers, Educators, and AI Specialists**
  Agile follows a cross-functional team approach, where developers, educators, and AI experts work collaboratively throughout the project lifecycle.

EdinBurg Peer Reviewed Journals and Books Publishers
Journal of Information and Technology
Vol. 5||Issue 3||pp 43-57||June||2025
Email: info@edinburgjournals.org||ISSN: 3080-9576

- **Enhanced System Quality through Continuous Testing**
  One of Agile's core principles is continuous testing and quality assurance. Instead of waiting until the end of the development cycle (as in Waterfall), Agile follows a Test-Driven Development (TDD) approach, where testing occurs at every iteration.
- **Cost-Effectiveness and Resource Optimization**
  Agile is also more cost-effective than Waterfall in the long run. In Waterfall, errors detected late in the project require expensive redesigns, whereas Agile fixes issues as they arise, preventing costly rework.
- **Increased Scalability for Future Enhancements**
  Your research proposes a platform that could later expand beyond secondary schools to include: Higher education institutions. Vocational training centers. Special education programs across Africa.

4.3. D-Moodle features and functionality



This feature will analyze videos, generate subtitles, and translate them into sign language using AI-generated avatars. It will enhance accessibility for deaf and hard-of-hearing users in D-Moodle.

Technologies Required

Feature	Technology
Speech-to-Text	OpenAI Whisper, Google Speech-to-Text API
Text-to-Sign Language	AI-driven sign language dataset (e.g., WLASL, RWTH-PHOENIX)
AI Avatar Generation	Unreal Engine, Blender, DeepMotion, SignAll
Machine Learning Models	TensorFlow, PyTorch, OpenPose for hand tracking
Integration with Moodle	Moodle Plugin (PHP, JavaScript)

4.4. Database Schema and Technical Implementation

The D-Moodle platform is built on PostgreSQL database with several keys tables:

Users Stores user account information, including Unique identifier for each user, Unique login name (must be unique), User's password (stored securely), User's full name shown throughout the application, User's email address (must be unique), Optional profile picture URL, User's role (default is "student"), When the account was created.

Courses Stores user account information, including, Unique identifier for each course, Course title, Detailed course description, Optional course thumbnail image, User ID of course creator, Course status (active, draft, archived), When the course was created.

Enrollments Stores user account information including, Unique enrollment ID, ID of enrolled user, ID of course user is enrolled in, User's progress percentage (0-100), Enrollment status (active, completed, etc.), When user enrolled in the course.

Media Stores user account information including, Unique media ID, Media title, Optional description, ID of user who uploaded, Optional course this media belongs to, Type of file (video/audio), Path to original uploaded file, Path to sign language processed version, Thumbnail image path, Length in seconds, Size in bytes, Processing status (uploading, processing, completed, error), Progress percentage during processing, JSON array of subtitle objects, signLanguageType: ASL or BSL, Avatar style (realistic, simplified, professional), Upload timestamp.

EdinBurg Peer Reviewed Journals and Books Publishers
Journal of Information and Technology
Vol. 5||Issue 3||pp 43-57||June||2025
Email: info@edinburgjournals.org||ISSN: 3080-9576

4.5. Case Studies: Implementation in Rwandan Secondary Schools

4.5.1 System Integration at GS Gitebe

GS Gitebe is a mixed secondary school that accommodates both hearing and non-hearing students. Despite Rwanda's inclusive education efforts, the school faces challenges, such as a lack of trained sign language interpreters and limited assistive technologies. Students with hearing impairments often struggle to keep up with lessons due to communication barriers.

4.5.2 System Integration at Nyabihu School for the Deaf

Nyabihu School for the Deaf is a specialized institution catering exclusively to students with hearing disabilities. Unlike GS Gitebe, this school provides a supportive environment specifically for deaf students, but it lacks advanced technological infrastructure to enhance the quality of education. Sign language instruction is standard, but access to diverse learning resources remains limited.

The Implementation process include:

- Increased Accessibility: at Nyabihu School for Deaf, Students could revisit lessons at their convenience. At GS Gitebe, Deaf students were able to follow lessons more effectively.
- Improved Comprehension: at Nyabihu School for Deaf, AI-driven translations helped clarify complex subjects. At GS Gitebe, The discussion forum enabled real-time engagement between hearing and non-hearing students.
- Technical Limitations: at Nyabihu School for Deaf, Some students required additional training to fully utilize the platform. At GS Gitebe, Internet connectivity issues occasionally affected system accessibility.

4.6. Comparative analysis of implementation

At GS Gitebe, the Moodle system was integrated into regular classroom teaching. Teachers recorded lectures, which were then processed by the AI system to generate sign language translations.

For NYABIHU School for the Deaf, the Moodle platform was used to supplement traditional teaching. Teachers uploaded sign language videos and interactive content to facilitate self-paced learning.

A comparative analysis revealed key differences in implementation:

Feature	GS GITEBE	NYABIHU School for the Deaf
Primary Challenge	Lack of interpreters for learners	Limited digital infrastructure
Main Advantage	Integration with hearing students	Tailored deaf-friendly content
Student Response	Positive but required adjustments	Highly receptive with rapid adoption
Teacher Adaptation	Moderate learning curve	Enthusiastic adoption
Technical Issues	Occasional internet disruptions	Need for additional training

4.7. Impact of D-Moodle on learning outcomes

The implementation of the D-Moodle platform demonstrated several positive impacts on learning outcomes for deaf and hard of hearing students:

- **Increased Learning Performance:** Students showed improved retention of knowledge after using the platform. The combination of video, images, and sign language enhanced their understanding of content and increased their attention span and interest in learning.
- **Enhanced Accessibility:** The platform enabled deaf and hard-of-hearing student's access educational content anywhere and anytime, overcoming geographical and temporal barriers.
- **Improved Communication:** The platform facilitated communication between deaf students and teachers through sign language videos, text, and Al-generated translations, bridging communication gaps.
- **Greater Autonomy:** Student gained greater autonomy in their learning as they could record classroom explanations, submit questions in sign language and receive responses in accessible formats.
- **Expanded Educational Opportunities:** By connecting students with sign language teachers based on expertise, the platform expanded educational opportunities for deaf and hard-of-hearing students, particularly those in rural areas.

5. Conclusion and Recommendation

5.1 Conclusion

In summary, the findings showed that using information technology can improve the education of deaf and hard-of- hearing students. The practical importance of these findings is that modified Moodle can be used for evaluation of non-interactive applications for deaf or hard-of-hearing students in secondary schools. We suggest extending the learning application to cover the entire lessons needs of the students. Complementary research on the effectiveness of the learning applications to measure the impact of the application on the behavioral change of deaf and hard-of- hearing students by case-control or before and after methods, could be an appropriate path for future research on this topic.

I have to propose and implement the teacher needs a simple basic skill that are not spent on the computer, nor does he need to be experienced in sign language or finger spelling. The teachers are required to submit their exercises and question keys only. Enhancement is the key to learning.

A conclusion that can be drawn from this research report is the dependency of Deaf and HH learners on others for their cognitive development. This means that Deaf and HH learners, process information differently from their hearing counterparts and they need (Deaf and HH learner) more assistance with this information processing. Furthermore, it means that teachers of Deaf and HH learners need extensive training in how to assist Deaf and HH learners in their information processing. What seems to be promising and what the current research report emphasized is the pedagogical principles Moodle is built on, for example, social constructivism, which could assist teachers in guiding learners with their cognitive

development. The question that should be asked is how Deaf and HH learners learned, and not what they learnt.

5.2 Recommendations

Promoting and implementing Moodle for deaf and Hard of Hearing (HH) students in Rwandan secondary schools requires a multifaceted approach that addresses accessibility, cultural context, and pedagogical best practices. Here are some key recommendations:

5.2.1 Accessibility and Usability

- **Sign Language Integration:** This is paramount. Video Integration: Embed sign language videos directly within Moodle courses, explaining key concepts, instructions, and assignments. Prioritize Rwandan Sign Language (RSL) content. AI-Powered Translation: Explore AI tools that can translate written text into RSL animations or videos. While still developing, this technology can be invaluable. Interactive Sign Language Glossaries: Create glossaries of key terms in RSL, linked to relevant course content.
- **Visual Learning Focus:** Multimedia Rich Content: Moodle should be populated with visually engaging materials: images, diagrams, videos, interactive simulations. Deaf students often rely heavily on visual learning. Clear Visual Hierarchy: Use Moodle's formatting tools to create a clear visual structure for course pages, making it easy to navigate and find information.
- **Screen Reader Compatibility:** Ensure the Moodle platform and all course content are fully compatible with screen readers for students who may have low vision in addition to deafness.
- **Customizable Interface:** Allow students to customize font sizes, colors, and contrast to suit their individual visual preferences.

5.2.2 Curriculum and Pedagogy

- Culturally Relevant Content: Adapt course materials to be culturally relevant to the Rwandan context. Use examples and scenarios that resonate with deaf Rwandan students.
- Collaborative Learning: Moodle's forums and wikis can facilitate communication and collaboration among deaf students. Encourage peer learning and support.
- Teacher Training: Provide extensive training to teachers on how to use Moodle effectively with deaf students, including best practices for visual teaching, sign language integration, and online communication.
- Differentiated Instruction: Moodle allows for differentiated instruction. Teachers can create different activities and resources tailored to the diverse learning needs of deaf students.

- Assessment Strategies: Employ diverse assessment methods beyond traditional written tests. Consider visual presentations, sign language demonstrations, and project-based assessments.

5.2.3 Technology and Infrastructure

- Reliable Internet Access: Ensure schools have reliable internet access, which is essential for Moodle usage. Advocate for affordable internet access for students.
- Device Availability: Provide students with access to computers or tablets. Explore partnerships with organizations that can donate devices.
- Technical Support: Establish a dedicated technical support system for teachers and students to address any technical issues that may arise.
- Moodle in RSL: Explore the possibility of localizing the Moodle interface into RSL to make it more accessible.

5.2.4 Collaboration and Partnerships

- Work with Deaf Community: Involve deaf educators, RSL interpreters, and deaf community members in the design and implementation of the Moodle platform. Their expertise is invaluable.
- Partner with Organizations: Collaborate with organizations working with deaf individuals in Rwanda to leverage their resources and knowledge.
- Government Support: Advocate for government support in providing funding, infrastructure, and training for e-learning initiatives for deaf students.

5.2.5 User Engagement and Activity

- Logins and Activity: Track the number of logins, frequency of access, and duration of user sessions. Moodle provides built-in reports for this. Are students logging in regularly? Are they actively participating in courses?
- Course Completion Rates: Analyze the percentage of students who complete courses. Low completion rates might indicate issues with course design, accessibility, or student motivation.
- Forum Participation: Monitor activity in forums, including the number of threads, replies, and participants. Are discussions lively and engaging? Or are forums underutilized?
- Assignment Submissions: Track the number of assignments submitted, on-time submissions, and grades. Are students meeting deadlines? Are there patterns in late submissions?
- Resource Access: Analyze which resources (files, videos, links) are accessed most frequently. This can help identify popular and effective learning materials.

- Quiz and Assessment Performance: Review student performance on quizzes and assessments. Are students demonstrating understanding of the material? Are there specific areas where students are struggling?
- Tool Usage: Track the usage of different Moodle tools (e.g., wikis, glossaries, databases). Are certain tools being neglected? Could they be better integrated into courses?

By addressing these recommendations, Rwanda can create a more inclusive and accessible education system for deaf students, empowering them to achieve their full potential through the use of Moodle and e-learning technologies.

References

Abowd, G. D. (1999). Classroom 2000: An experiment with the instrumentation of a living educational environment. IBM Systems Journal, 38(4), 508–530.

Bass, J., & Coutaz, J. (1991). Developing software for the user interface. Addison-Wesley.

Degen, L., Mander, R., & Salomon, G. (1992, May). Working with audio: Integrating personal tape recorders and desktop computers. In Proceedings of ACM CHI'92 Conference (pp. 413–418).

Essa, I., & Pentland, A. (1994). A vision system for observing and extracting facial action parameters (pp. 76–83). IEEE Computer Society.

Feynman, R. (1965). The character of physical law. MIT Press.

Ghirardini, B. (2021). E-learning methodologies and good practices (2nd ed.). FAO.

Goldberg, J. H., & Kotval, X. P. (1999). Computer interface evaluation using eye movements: Methods and constructs. International Journal of Industrial Ergonomics, 24, 631–645.

Gul, S. B. A. (2015). E-learning revolutionizing education: An exploratory study. University of Kashmir.

Hilborn, R., & Mangel, M. (1997). The ecological detective: Confronting models with data. Princeton University Press.

Hindus, D., Mainwaring, S. D., Hagstrom, A. E., Leduc, N., & Bayley, O. (2001, April). Casablanca: Designing social communications devices for the home (pp. 325–332).

Kaushal, N. (2016). E-learning: Meaning, importance, principles and relevance in higher education. University of Lucknow.

Knuth, D. E. (1998). The art of computer programming, volume 2: Seminumerical algorithms. Addison-Wesley.

Kotzer, S., & Elran, Y. (2012). Learning and teaching with Moodle-based e-learning environments, combining learning skills and content in the fields of Math and Science & Technology.

Meanings and definitions of words at. (n.d.). Dictionary.com. Retrieved from https://www.dictionary.com

Moodle Statistics. (2015). Official website. Retrieved from *https://moodle.net/stats/*

Nichols, M. (2007). E-learning in context. Retrieved from *https://unesdoc.unesco.org*

Oproiu, G. C. (2015). A study about using e-learning platform (Moodle) in university teaching process. Procedia - Social and Behavioral Sciences, 180, 426–432.

Oyelere, S. S., Suhonen, J., Wajiga, G. M., & Sutinen, E. (2018). Design, development, and evaluation of a mobile learning application for computing education. Education and Information Technologies, 23(1), 467-495.

Palincsar, A. S. (1998). Social constructivist perspectives on teaching and learning. Annual Review of Psychology, 49, 345–375.

Redhuan Samsudin, M., Sulaiman, R., Guan, T. T., & Yusof, A. M. (2020). The effect of mobile application learning style on mute deaf students' motivation.

Sandler, W., & Lillo-Martin, D. (2006). Sign language and linguistic universals. Cambridge University Press.

Stasinakis, P., & Kalogiannakis, M. (2015). Using Moodle in secondary education: A case study of the course "Research Project" in Greece.