PIONEER AND ACADEMIC STUDIES IN EDUCATIONAL SCIENCES

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Artificial Intelligence Applications in Physics Education: Electrical Circuits Example

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ABSTRACT

This study explores the use of artificial intelligence (AI) applications in physics education, focusing on electrical circuits. Conducted with 30 tenth-grade students at a state high school in Uşak, the research employed an action research model over two sessions (2+2 hours). The AI-supported instruction covered key concepts, including series and parallel connections of resistors and generators. Data were collected through classroom observations and student interviews, allowing for qualitative analysis. The findings indicate that AI tools increased student engagement, improved conceptual understanding, and supported individualized learning. Students found AI visuals and simulations particularly helpful in grasping abstract concepts. However, challenges such as occasional technical issues, varying levels of digital literacy, and time constraints during activities were noted. Overall, integrating AI in physics lessons yielded positive educational outcomes. Future implementations should provide better teacher training, more robust infrastructure, and additional class time to fully exploit AI's potential in science education.

Key Words: Artificial intelligence, physics education, electrical circuit,

INTRODUCTION

The integration of artificial intelligence (AI) into educational settings has become a significant area of interest in recent years, offering new opportunities to personalize learning, support real-time feedback, and enhance student engagement across disciplines (Park & Kwon, 2024). In the context of physics education, where abstract concepts such as electric current, voltage, and circuit configurations challenge learners' conceptual understanding, AI-based tools have shown promise in making invisible phenomena more accessible through visualizations, simulations, and adaptive learning environments (Borısova, Hadzhıkoleva & Hadzhıkolev, 2023). Studies have emphasized that traditional teaching methods often fail to correct misconceptions related to electrical circuits, leading to fragmented knowledge and low academic performance (Kumaş, 2022). Collaborative and technology-supported approaches, particularly those enriched with AI, are gaining traction for their capacity to foster active learning, peer interaction, and deeper cognitive engagement (Aimeur, Frasson & Dufort, 2000). As the demands of 21st-century education evolve toward more student-centered and technologically enriched learning experiences, the integration of AI in science education is not only timely but essential. It offers a forward-looking pedagogical shift that aligns with global trends in digital transformation and supports the development of scientific literacy and problem-solving skills critical for future generations (Ahmed, Mohamed, Zeeshan & Dong, 2020).

The Role of Artificial Intelligence in Contemporary Education

The rapid advancement of AI technologies has brought transformative changes to the field of education, influencing both teaching methodologies and learning experiences. As AI applications increasingly permeate educational environments, they are redefining the roles of teachers and students by facilitating personalized learning, real-time feedback, and data-informed instructional strategies (Rospigliosi, 2023). Particularly in science education, where abstract concepts and complex processes often challenge student comprehension, AI offers significant pedagogical advantages (Cooper, 2023).

Physics, as a foundational branch of science, presents unique challenges for high school learners. Abstract notions such as force, energy, motion, and electricity require mathematical proficiency and deep conceptual understanding. Traditional teaching methods, often reliant on textbook explanations and static diagrams, may fall short in engaging diverse learners or addressing misconceptions (Kaltakci-Gurel, Eryilmaz & McDermott, 2016). In this context, AI-supported educational tools such as intelligent tutoring systems, adaptive simulations, and virtual laboratories have emerged as promising innovations to enhance conceptual clarity and student motivation (Chen, Chen & Lin, 2020).

AI technologies can adapt instructional content to individual learning needs, enabling differentiated instruction that was previously difficult to implement at scale. For instance, in topics like electrical circuits, students benefit from AI-driven simulations that allow them to manipulate circuit elements and instantly observe outcomes (Mahligawati, Allanas, Butarbutar & Nordin, 2023). Such dynamic, interactive environments foster inquiry-based learning and provide immediate, personalized feedback, helping students correct misconceptions in real time. Moreover, AI tools can support teachers in identifying student difficulties through learning analytics, informing targeted interventions, and more effective instructional design (Kortemeyer, 2023).

Despite these benefits, the integration of AI into science and physics education is not without challenges. Concerns related to infrastructure, teacher preparedness, digital literacy, and equitable access must be addressed to realize the potential of AI-enhanced learning fully (Wink & Bonivento, 2023). Nevertheless, the growing body of research and classroom applications indicates that when thoughtfully implemented, AI can play a vital role in reshaping physics education, making it more engaging, accessible, and effective for all learners.

Conceptual Barriers in Learning Electrical Circuits

Electrical circuits represent a core topic in high school physics curricula, yet they continue to pose significant conceptual challenges for students. Specifically, understanding series and parallel connections of resistors and generators requires not only a grasp of the physical arrangement of circuit components but also the ability to reason abstractly about current, voltage, resistance, and their interrelationships (Moodley & Gaigher, 2019). Numerous studies in physics education have shown that students often enter formal instruction with pre-existing misconceptions about how electricity behaves in circuits, and that traditional teaching methods frequently fail to address or correct these misconceptions effectively. One of the most common difficulties lies in the misunderstanding of current flow. Students often assume that electric current is "used up" as it moves through a circuit, leading to the false belief that bulbs in a series circuit will receive less current the farther they are from the power source. In parallel circuits, learners may struggle to grasp how current divides between branches or how the voltage across each branch remains equal. The inability to distinguish between the roles of current and voltage, or to apply Ohm’s Law in multi-component systems, further complicates the learning process (Sencar, Yılmaz & Eryılmaz, 2001).

Another barrier is the abstract nature of electricity, which is invisible and cannot be directly observed. While diagrams and verbal explanations help to some extent, they often fall short in conveying dynamic processes such as current distribution and potential difference in a way that is intuitive for students (Peşman & Eryılmaz, 2010). Without hands-on experiences or interactive visualizations, learners may develop superficial or fragmented understandings that hinder their ability to solve problems or apply knowledge to new contexts.

Addressing these conceptual obstacles requires instructional strategies that promote active engagement, multiple representations, and opportunities for inquiry. Recent research points to the potential of simulation-based environments and technology-enhanced learning tools to bridge the gap between theoretical understanding and practical application (Ogegbo & Ramnarain, 2022). In particular, AI-supported learning environments offer a promising avenue for individualized feedback and conceptual reinforcement. A clearer understanding of the nature and sources of students’ misconceptions is essential for designing effective interventions that support deeper learning in electrical circuits (Wu & Tegmark, 2019).

The Potential of AI-Supported Learning in Physics Classrooms

The integration of AI technologies into education has opened new pathways for addressing persistent teaching and learning challenges, particularly in physics, a discipline known for its abstract concepts and mathematical complexity (Verawati & Nisrina, 2024). Traditional physics instruction often relies on lecture-based delivery and static visuals, which can limit students’ engagement and hinder deep conceptual understanding (Wieman & Perkins, 2005). AI-enhanced learning environments, on the other hand, offer interactive, adaptive, and personalized experiences that can significantly improve both teaching effectiveness and student learning outcomes (Shafiq, Sami, Bano, Bano & Rashid, 2025).

AI applications in physics classrooms can take various forms, including intelligent tutoring systems, adaptive simulations, virtual laboratories, and learning analytics platforms. These tools analyze students' responses in real time, identify misconceptions, and adjust content accordingly. For example, when learning about the behavior of current and voltage in series and parallel circuits, students can interact with AI-powered simulations that provide instant visual feedback. This real-time interactivity helps make invisible phenomena more concrete, aiding the development of accurate mental models and correcting faulty reasoning through guided exploration (Feng, 2018).

One of the most promising features of AI is its ability to support differentiated instruction (Rizvi, Waite & Sentance, 2023). Every student learns at a different pace and brings unique prior knowledge and misconceptions to the classroom. AI systems can tailor learning paths to individual needs, ensuring that students receive instruction and practice that match their current level of understanding. This personalized approach not only promotes conceptual clarity but also boosts motivation and engagement, especially among learners who might struggle with conventional teaching methods (Schmidt & Strasser, 2022). Additionally, AI tools can assist educators in tracking progress, analyzing learning patterns, and identifying students who need targeted support. By providing data-driven insights, AI empowers teachers to make informed instructional decisions and to intervene proactively (Chiu, 2021).

Despite the potential of AI in physics education, challenges such as limited technological infrastructure, lack of teacher training, and concerns about data privacy remain. However, with thoughtful implementation and support, AI-enhanced learning stands as a transformative tool capable of making physics education more inclusive, interactive, and effective in the 21st-century classroom (Al-Kamzari & Alias, 2025).

Electrical circuits, particularly the concepts of series and parallel connections of resistors and generators, present significant conceptual challenges for high school students due to their abstract nature and the invisibility of underlying physical processes. Traditional instruction often fails to support deep understanding and active student engagement (Gunstone, Mulhall & McKittrick, 2009). In response, this study investigates the integration of AI applications into physics instruction as a means to enrich conceptual learning and promote student-centered engagement. Grounded in collaborative learning principles, the action research approach enables the active participation of both students and the teacher in shaping the instructional process. Data were gathered through classroom observations and student interviews, allowing for an in-depth, qualitative exploration of how AI-supported environments influence group-based learning dynamics, student understanding, and classroom interaction. This study seeks to contribute to the growing body of research on how emerging technologies can be effectively integrated into science education in real-world classroom settings.

1. How does using of AI-supported applications influence students' conceptual understanding of electrical circuits in a collaborative learning environment?
2. What are the observed changes in student engagement and group interaction during AI-supported physics instruction?
3. What are the students' perceptions and experiences regarding using of AI tools in learning about series and parallel circuits?

METHOD

Research Design

This study employed a collaborative and application-based action research design grounded in qualitative research methods, aiming to explore the impact of artificial intelligence (AI) applications on students' conceptual understanding in physics education. Action research was chosen due to its suitability for addressing real-time instructional challenges and promoting reflective practice in authentic classroom settings (Yıldırım & Şimşek, 2018). The collaborative nature of the model enabled active participation and interaction among students, aligning well with the study's focus on peer learning and shared exploration of scientific concepts. The application-based structure allowed students to engage directly with AI-supported tools, fostering hands-on experiences that are essential for internalizing abstract topics like electrical circuits. Qualitative data were gathered through systematic observations and semi-structured interviews, which are well-suited for capturing the depth and complexity of students' learning experiences, behavioral changes, and perceptions. This design made it possible to closely monitor the learning process, document instructional adaptations, and generate rich, practice-oriented insights to inform future educational implementations.

Sample

The study was conducted during the 2024–2025 academic year at a public high school in Uşak province that admits students through the central high school entrance exam and is ranked within the 8th percentile, indicating a relatively high academic profile. The participant group consisted of 30 tenth-grade students (19 female, 11 male). While simple random sampling was initially used to ensure impartiality in group selection, the qualitative nature of the study required a more deliberate approach to participant selection to ensure depth and richness of data. Therefore, in determining the participants, maximum variation sampling and criterion sampling, both of which are forms of purposeful sampling, were employed. These methods were chosen to capture a broad range of student perspectives and to include individuals who met specific criteria relevant to the study context. Purposeful sampling is particularly suited for qualitative research, as it allows researchers to select individuals who are most likely to provide meaningful, detailed, and relevant information aligned with the study's goals, while also offering flexibility regarding the number of participants (Yıldırım & Şimşek, 2018).

Data Collection Tools

Given the study's basis in action research and its reliance on cooperative learning processes, qualitative data were collected through semi-structured interviews and systematic classroom observations. Interviews were chosen to gain insight into students' perceptions, conceptual understanding, and attitudes toward AI-supported instruction in physics, as they allow participants to express their views in their own words, providing access to the cognitive and emotional dimensions of learning. To ensure the clarity and appropriateness of the interview instrument, a five-question pool was initially created based on the research aims and principles of item clarity. Care was taken to ensure that questions were clear, free of ambiguity, and did not contain multiple embedded constructs. The draft interview form was then reviewed by three experts specializing in physics education and qualitative research from different universities. Based on their feedback, two questions were removed, and a three-question final form was prepared. During data collection, the purpose of the study was explained to all students. Only those who voluntarily agreed to participate and whose school administrators provided institutional approval were included. Interviews lasted approximately 15 minutes, and explicit verbal consent was obtained from each participant for audio recording, under ethical research practices (Berg et al., 2001; Merriam, 2001). During interviews, the researcher maintained a neutral demeanor, avoiding suggestive language, facial expressions, or gestures that could influence participant responses.

In parallel with interviews, classroom observations were conducted to document real-time behaviors, student interactions, and the nature of group collaboration during AI-enhanced instruction. For this purpose, the Mathematics and Science Classroom Observation Profile System (M-SCOPS) developed by Stuessy, Parrott & Foster (2003) were adapted into a structured observation tool aligned with the objectives of the present research. The modified observation protocol captured indicators related to student participation, inquiry-based engagement, peer cooperation, and the integration of AI tools in classroom activities. Observations provided an external, evidence-based layer of analysis, supporting data triangulation and strengthening the study’s overall credibility.

Validity and Reliability

Several strategies were employed throughout the data collection and analysis process to ensure validity. First, expert validation was sought for the interview questions to ensure content validity, and questions were refined according to expert recommendations (Yıldırım & Şimşek, 2018). Using interviews and observations allowed for methodological triangulation, enhancing construct validity by capturing data from multiple sources and perspectives. In addition, participant selection through maximum variation sampling increased the likelihood of capturing a wide range of experiences, thereby improving transferability and depth of findings (Franklin & Ballan, 2001).

For reliability, inter-coder consistency was evaluated based on the framework proposed by Miles and Huberman (2015). Following transcription, all qualitative data were independently coded by two researchers. To assess the consistency of coding, the reliability coefficient was calculated using the formula: Reliability = Number of Agreements / (Number of Agreements + Number of Disagreements). The inter-coder reliability was determined separately for each interview question, resulting in values of 90% for the "Can you describe how the use of artificial intelligence applications (such as simulations or visual tools) influenced your understanding of electrical circuits, especially series and parallel connections?" question, 84% for the "How did working in groups while using AI-based materials affect your learning experience during the physics lesson?", and 92% for the "What difficulties or challenges did you experience while learning about electrical circuits with the help of artificial intelligence applications?". These results demonstrate a high level of coding reliability, supporting the trustworthiness of the findings (Miles & Huberman, 1994).

Data Analysis

In the analysis of observation data, content analysis was employed to systematically examine classroom behaviors, group dynamics, and the integration of artificial intelligence applications into instructional practices. Content analysis is a widely accepted qualitative data analysis technique that enables researchers to identify recurring patterns, group similar phenomena, and interpret their meanings in a way that enhances clarity and accessibility for both readers and researchers (Yıldırım & Şimşek, 2016). Observation notes were reviewed multiple times, and codes were derived inductively based on student behaviors, interaction patterns, and teacher facilitation strategies observed during AI-supported physics lessons. To increase the interpretability of the findings, direct excerpts from observation records were included under related tables and thematic explanations. To maintain confidentiality and ensure consistency, students were coded using the abbreviation “S” followed by a number (e.g., S1, S2, … S30). These quotes were carefully selected to reflect the diversity of student responses and group interactions, thus enhancing the depth and credibility of the analysis. The use of content analysis in this context not only allowed the researcher to reveal meaningful themes from complex classroom dynamics but also contributed to the triangulation of data by aligning observation results with interview findings (Yıldırım & Şimşek, 2016).

FINDINGS

The findings of the study, obtained through classroom observations and student interviews, are presented under three themes aligned with the research questions and reflect the impact of AI-supported applications on conceptual understanding, student engagement, and learner perceptions within a collaborative learning environment.

Enhancing Conceptual Understanding of Electrical Circuits through AI-Supported Collaborative Learning

To explore how AI-supported collaborative learning environments impact students' conceptual understanding of electrical circuits, semi-structured interviews were conducted with participating students. The interview data were analyzed through content analysis, and recurring patterns were grouped into themes, categories, and codes. The findings presented in Table 1 reflect students' views on how the integration of AI tools and group-based learning activities influenced their grasp of series and parallel circuits. These results offer insight into the cognitive processes and experiences that shaped students' understanding throughout the instructional intervention.

Table 1: Interview Findings on Conceptual Understanding in AI-Supported Collaborative Learning

Theme	Category	Code	Sample Student Quote
Improved Conceptual Clarity	Visualization of Abstract Concepts	Simulations helped visualize current flow	"I couldn't imagine how electricity flows before, but with the animation, I saw it more clearly." (S7)
	Real-Time Feedback	Immediate correction of misconceptions	"The AI tool corrected my mistake when I connected it wrong—it helped me see my error quickly." (S12)
Collaborative Meaning-Making	Peer Discussion Support	Explaining concepts to each other	"While using the app, we talked a lot about why the light was dimmer—this made it stick in my mind." (S5)
	Shared Problem Solving	Group members identified and fixed circuit errors together	"I didn't understand parallel circuits at first, but we solved it as a group

			using the simulation." (S16)
Support for Different Learning Paces	Individual Exploration	Self-paced simulation-based exploration	"I repeated the activity until I understood—no one rushed me." (S21)
	Reduced Fear of Mistakes	Less anxiety while experimenting	"With the simulation, I wasn't scared of making mistakes like I am in real labs." (S3)

The data suggest that AI-supported instruction significantly enhanced students' conceptual understanding of electrical circuits. Students reported that visual and interactive features of AI applications made abstract ideas, such as current flow, resistance, and circuit behavior, more comprehensible. In a collaborative learning context, peer interactions and group discussions reinforced their understanding, as students articulated reasoning and resolved misunderstandings together. Furthermore, the adaptive and error-tolerant environment of AI tools allowed students to learn at their own pace, reducing anxiety and supporting deeper learning through trial and error.

The following table presents observation-based findings regarding students' conceptual understanding of electrical circuits within the AI-supported collaborative learning environment.

Table 2: Observation Findings on Conceptual Understanding in AI-Supported Collaborative Learning

Theme	Category	Code
Cognitive Engagement	Conceptual Reasoning	Students compare outcomes of series vs. parallel setups
	Prediction and Reflection	Students make predictions and evaluate circuit behavior
Visual-Spatial Learning Support	Interpretation of Simulations	Students interpret voltage/current flow through visuals
	Use of Dynamic Representations	Real-time response to changes in circuit configuration
Collaborative Meaning-Making	Peer Explanation	Students explain circuit logic to each other
	Negotiated Understanding	Students reach consensus on how circuits function
Inquiry-Based Learning Behaviors	Testing Hypotheses	Students test expected outcomes by adjusting parameters
	Identifying Misconceptions	Misunderstandings are discussed and corrected in groups

Observation data presented in Table 2 demonstrate that the integration of AI-supported applications into collaborative physics learning environments significantly contributed to students' conceptual understanding of electrical circuits. Students were observed engaging in cognitively rich activities such as predicting outcomes, testing hypotheses, and interpreting visual representations of current and voltage in series and parallel circuits. These behaviors suggest a shift from surface-level memorization to deeper, inquiry-based learning. The real-time feedback provided by AI simulations allowed learners to visualize abstract principles dynamically, facilitating the development of more accurate mental models. Furthermore, peer discussions and collaborative problem-solving activities played a critical role in the refinement of students' ideas, as they engaged in collective meaning-making processes. The presence of peer explanation and negotiated understanding indicates that the learning process was supported not only by technological tools but also by socially constructed interactions. Overall, the observations confirm that AI-supported collaborative learning environments promote both individual conceptual growth and group-based cognitive engagement in physics education.

Observed Shifts in Student Engagement and Group Dynamics during AI-Integrated Physics Instruction

The table below summarizes the interview findings relating to changing student engagement and group dynamics during AI-supported physics instruction.

Table 3: Interview Findings on Student Engagement and Group Dynamics

Theme	Category	Code	Sample Student Quote
Increased Student Engagement	Curiosity and Motivation	Willingness to try new tools	"I was curious about how the simulation would work, so I paid more attention." (S9)
	Focused Participation	Staying on task during group activities	"Normally I get distracted, but with the app, I stayed focused the whole time." (S14)
Strengthened Group Interaction	Active Communication	Asking and answering questions with peers	"We were constantly talking about how to fix the circuit—it felt like a real team effort." (S4)
	Role Distribution	Taking turns and assuming roles naturally	"One of us clicked through the simulation while others explained what to do." (S18)
Peer Learning and Support	Peer Teaching	Explaining to others who struggled	"I understood it quickly and helped my friend—

			teaching her helped me too." (S22)
	Group Problem Solving	Collaboratively overcoming technical or conceptual issues	"When the circuit didn't work, we figured it out together step by step." (S2)
Positive Learning Environment	Reduced Anxiety	Comfortable atmosphere compared to traditional lessons	"Because it was a group task with the app, I wasn't afraid of being wrong." (S10)
	Increased Enjoyment	Expressed satisfaction with learning process	"This was one of the most fun physics lessons we've had." (S6)

The interview data indicate that using AI applications in a collaborative setting significantly enhanced both student engagement and the quality of group interactions. Students were more motivated and focused when using interactive AI tools, which supported sustained attention during complex tasks like constructing and analyzing circuits. Collaboration was enriched by active communication and shared responsibilities, with students naturally adopting complementary roles within their groups. Moreover, the AI-supported environment fostered a non-threatening, engaging atmosphere that encouraged risk-taking and peer teaching. These dynamics contributed to deeper learning and a more positive classroom culture.

The table below presents observation findings highlighting shifts in student engagement and group dynamics during AI-integrated physics instruction.

Table 4: Observation Findings on Student Engagement and Group Dynamics in AI-Integrated Physics Instruction

Theme	Category	Code
Behavioral Engagement	Task Focus	Students stay on task throughout simulation activities
	Time on Learning	Minimal off-task behavior observed during group work
Emotional Engagement	Enthusiasm and Curiosity	Students show excitement when manipulating simulations
	Motivation to Participate	Voluntary involvement in group discussions
Group Interaction	Role Distribution	Students take on roles (e.g., simulator, recorder, explainer)
	Peer Support	Students assist each other with tool usage and concepts

Collaboration Quality	Shared Decision-Making	Students jointly decide on circuit configurations
	Conflict Resolution	Disagreements discussed and resolved constructively

Observation data in Table 4 indicate notable improvements in student engagement and group dynamics during AI-integrated physics instruction. Students exhibited sustained behavioral engagement, with minimal off-task behavior and high levels of concentration during activities involving circuit simulations. Emotional engagement was also prominent; learners demonstrated curiosity and enthusiasm, particularly when manipulating AI-based tools and observing immediate visual outcomes. These behaviors suggest that the AI environment contributed to a heightened intrinsic motivation. Group interactions were characterized by clear role distributions, cooperative decision-making, and mutual assistance, reflecting a positive shift toward structured and productive collaboration. Additionally, students were seen negotiating roles and resolving disagreements respectfully, which indicates an increase in social cohesion and communication skills. Overall, the observations suggest that the integration of AI tools into physics instruction not only enhances individual participation but also strengthens group dynamics by fostering an environment conducive to shared responsibility, peer learning, and active engagement.

Student Perceptions and Experiences with AI Tools in Learning Series and Parallel Circuits

The following table displays interview findings on students' perceptions and experiences with AI tools used in learning series and parallel circuits.

Table 5: Interview Findings on Student Perceptions and Experiences with AI Tools

Theme	Category	Code	Sample Student Quote
Perceived Usefulness of AI Tools	Concept Visualization	Helped clarify differences between circuit types	"With the animation, I finally understood how parallel circuits share current." (S11)
	Immediate Feedback	Identified mistakes during simulation	"The simulation told me right away if my connection was wrong." (S8)
Learning Experience	Increased Confidence	Felt more capable when using AI tools	"Normally I hesitate with circuits, but the app made me feel more sure of myself." (S15)

	Improved Understanding	Concepts became clearer than in textbook lessons	"It was easier to understand than when the teacher only used the board." (S27)
Technology Acceptance	Ease of Use	Found AI interface intuitive	"It was easy to use—I didn't need much help to try things out." (S13)
	Preference for AI Tools	Compared favorably with traditional instruction	"I wish we used this kind of app in all our science classes." (S19)
Challenges Encountered	Technical Issues	Occasional slow response or device limitations	"Sometimes it lagged, and we had to restart the simulation." (S3)
	Need for Guidance	Wanted more instruction before using the tool	"At first, I was confused about where to click—it got better after the teacher helped." (S20)

Students' perceptions of using AI tools in learning series and parallel circuits were largely positive. Most students found the applications visually helpful, reporting that dynamic simulations improved their conceptual grasp of how current behaves in different circuit structures. They also described feeling more confident and engaged, particularly due to instant feedback and the ability to test circuits freely. In terms of usability, students generally found the tools accessible and intuitive, with many expressing a preference for more technology-integrated lessons. However, some challenges were noted, including minor technical glitches and the initial learning curve in navigating the software. These findings suggest that while AI tools significantly enhance learning experiences, their effectiveness is optimized when accompanied by clear guidance and robust infrastructure.

The table below presents observation findings regarding students' perceptions and experiences with AI tools during the learning of series and parallel circuits.

Table 6: Observation Findings on Student Perceptions and Experiences with AI Tools in Learning Series and Parallel Circuits

Theme	Category	Code
Perceived Usefulness	Clarity of Concept	Students express understanding is easier with simulations
	Application of Knowledge	Students transfer concepts from simulation to worksheet tasks
Ease of Use	Tool Navigation	Students operate AI tools with minimal guidance

	Autonomy in Learning	Students explore simulations independently
Affective Response	Enjoyment	Students show positive emotions during tool use
	Reduced Anxiety	Learners appear less hesitant compared to traditional tasks
Feedback Orientation	Response to Visual Feedback	Students immediately adjust based on simulation outcomes
	Iterative Exploration	Students repeat actions to test and confirm understanding

Observations related to student perceptions and experiences with AI tools in learning series and parallel circuits suggest that learners found the technology both accessible and valuable. Students were able to navigate the tools with ease and demonstrated autonomy in using the simulations to construct knowledge. The perceived usefulness of AI applications was evident in the way learners successfully transferred their conceptual understanding from digital simulations to paper-based activities. Emotional responses were overwhelmingly positive; students displayed enjoyment and confidence, indicating a reduction in typical performance anxiety associated with physics problem-solving. Moreover, the immediate visual feedback provided by the AI environment encouraged iterative learning, students frequently tested, revised, and confirmed their understanding through repeated interactions with the simulations. These findings imply that when designed effectively, AI tools can foster a student-centered, low-stress learning environment that supports both conceptual clarity and affective engagement in science education.

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

The interview findings revealed that AI-supported tools contributed significantly to students' conceptual understanding of electrical circuits, particularly in differentiating between series and parallel connections. Students reported that visual simulations allowed them to grasp abstract principles more concretely, which aligns with the findings of Bundy, Chater and Muggleton (2023), who emphasized the power of AI in enhancing cognitive processing of scientific concepts. Furthermore, the use of simulations enabled learners to observe the dynamic behavior of current and resistance in real time, which increased comprehension beyond static textbook visuals. These results support studies by Mintzes, Wandersee, and Novak (1997), which underline the role of interactive environments in promoting meaningful learning in science.

Students also expressed marked improvement in engagement and collaborative behavior, highlighting peer communication, task division, and group-based problem solving as key positive outcomes of AI-integrated instruction. These observations mirror the findings of Kumaş (2023), who stated that well-structured technological tools can foster productive collaborative learning if learners engage actively with both content and peers. AI tools created opportunities for equitable participation by allowing students to test ideas without fear of failure, fostering a psychologically safe learning environment. However, the findings also pointed to limitations such as varying digital competencies and occasional technical issues, concerns echoed in studies by Nistor (2016), who note the importance of digital literacy support when integrating AI tools into classrooms.

Student perceptions and emotional responses to AI usage were predominantly positive. Many preferred AI-supported methods over traditional instruction, citing ease of use, interactivity, and immediate feedback as key advantages. This aligns with the Technology Acceptance Model (Davis, 1989), which predicts that perceived usefulness and ease of use significantly affect learners' adoption of educational technologies. Nonetheless, initial confusion and the need for clearer onboarding indicate that technology integration must be accompanied by explicit scaffolding and teacher facilitation. Based on these findings, it is recommended that future implementations ensure teacher training, infrastructure readiness, and student orientation programs. Expanding the integration of AI-supported tools across other physics topics may further reinforce conceptual understanding and stimulate student interest in science education.

The observation findings of this study reveal that AI-supported collaborative learning environments have a meaningful and positive effect on students' conceptual understanding of electrical circuits. Students were observed engaging in cognitively demanding tasks such as predicting outcomes, modifying circuit designs, and interpreting simulation feedback. These behaviors demonstrate a transition from passive reception to active construction of knowledge, particularly in understanding abstract physics concepts like current and voltage distribution in series and parallel circuits. The structured and interactive nature of AI tools enabled learners to visualize dynamic circuit behaviors, thereby strengthening their conceptual models.

When these findings are evaluated in the context of existing literature, the results align closely with the studies of Dunn, and Ramnarain (2020), who found that simulation-supported science instruction enhances both cognitive engagement and inquiry-based skills. Similarly, the observed increase in student motivation, role distribution, and cooperative decision-making during group work is consistent with Gallini's (2001) assertions on the social dimension of learning in technology-mediated environments. The reduction of student anxiety and the emergence of positive emotions during AI tool use also mirror results reported by Tzanavari, and Tsapatsoulis (2010), who emphasized the affective benefits of interactive digital learning tools.

Based on these findings, it is suggested that physics instruction in secondary education incorporate AI-supported environments not as supplementary materials but as integral components of conceptual teaching strategies. To maximize the benefits observed, educators should be provided with professional development focused on the pedagogical integration of AI tools, and schools should ensure adequate technological infrastructure. Additionally, designing learning scenarios that combine simulation-based exploration with structured peer collaboration can further reinforce understanding. Future research could explore long-term effects of such integration and examine its impact on different topics in physics beyond electrical circuits. The current study underscores the transformative potential of AI in creating more meaningful, interactive, and student-centered learning experiences in science education.

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Unveiling Paradigms: Onto-Epistemic Coherence in Translanguaging Research

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ABSTRACT

Translanguaging has become an important and powerful pedagogical and theoretical framework for multilingual education which constrains the dominant monolingual ideology and opens spaces of epistemic justice. Nonetheless, while there remains an understanding of translanguaging's conceptual potential, many empirical studies do not engage their research explicitly in relation to coherent epistemological and ontological positions. By failing to engage thoroughly with this philosophical aspect of translanguaging, its critical and decolonizing potential is reduced. This current study offers qualitative, in-depth critical analysis of three contemporary empirical studies on translanguaging conducted in 2025 and sourced from ERIC. Taking as a research framework, philosophical evaluation grounded in constructivist, interpretivist and critical research paradigms, the researcher provides an in-depth critical evaluation of the ontological and epistemological assumptions evident in each study, as well as the extent and coherence within and across studies of the research design. On the one hand, the researcher found that these three studies demonstrated differing appellate reaches of coherency, and on the other hand, the three studies expressed differing assumptions. For instance, the studies from Iran and Indonesia tended to implicitly present a form of interpretivist and constructivist alignment; conversely, the study from South Africa tended to present instrumentalist and positivist assumptions. In all three cases, the articulation of ontological positions is lacking at best and epistemological assumption in terms of methodological decisions is evident but inconsistently manifested. Establishing transparent and coherent paradigmatic articulations of research plans is needed in translanguaging research. Otherwise, translanguaging risks being presented and understood as pedagogical practices instead of being maintained as a counter-hegemonic and theoretically robust framework. In conclusion, the researcher argues for a more thorough engagement with decolonial and Southern epistemologies in future translanguaging studies to avoid losing the political and ethical integrity of translanguaging.

Key Words: Translanguaging, Epistemology, Ontology, Qualitative Research Paradigms, Multilingual Education.

INTRODUCTION

In educational research, paradigmatic influences, epistemological and ontological orientations are not exceptional but rather substantive elements that exist within the conduct of study in educational research, and the interpretive frames and contributions it affords. Epistemology, broadly understood, relates to nature and source of knowledge, or what counts as legitimate knowledge, and the means and nature of acquiring such knowledge

(Creswell & Poth, 2018). Ontology, in turn, relates to the nature of reality, including the assumptions about whether things exist, how entities can be categorized, and the assumptions about the uses of terms like language, identity and learning (Lincoln, et al., 2011). These philosophical orientations are particularly salient in qualitative inquiry, and particularly critical due to the situated nature of them within a complex, contextually situated setting, such as the language practices in multilingual classrooms.

Translanguaging theory presents the idea that multilingual speakers orchestrate and strategically deploy their entire linguistic repertoires, often in ways that challenge traditional conceptions of separating ways of speaking. Therefore, Pennycook (2020) asserts that translanguaging is much more than a classroom pedagogy; it is also a way of rethinking what it means to use language, to learn, and to understand identity, especially in postcolonial and multilingual contexts. In the last ten years, translanguaging has more and further widely developed as a perspective and a framework for transformative possibilities, not only in applied linguistics and educational contexts. In addition to its pedagogical practice, translanguaging is also increasingly regarded as a sociopolitical stance for resisting named languages and the monolingual order (Canagarajah, 2012; Wei & Garcia, 2022).

While critical potential exists, translanguaging research has increasingly been critiqued for its lack of philosophical coherence. Many of its empirical studies might use the language of translanguaging and aspire to translanguaging practices, while their methodologies do not always reflect consistent ontological and epistemological assumptions. There is little doubt that translanguaging is generally used as an umbrella term without a theoretical frame. Jaspers and Madsen (2019) explicitly observe translanguaging studies' frequent ambiguity on concepts as well as their tendency to ignore the ideological and critical dimensions of translanguaging. García and Kleyn (2016) similarly express that unless framed within transformative and decolonial paradigms, translanguaging will continue to be reduced to a strategy for pedagogy. Flores and Rosa (2015) also essentially found that translanguaging study is often reliant on the same raciolinguistic ideologies as the hegemonic structures with which previous studies criticized, and even when sounding progressive, studies cannot examine the epistemic structures underlying what constitutes legitimate language use to recognize their role reproducing raciolinguistic ideologies. Thus, it is not enough to simply implement translanguaging; rather, scholars must think about what philosophical position they are committing to with their implementation, while seeking to take a critical position within translanguaging.

The imperative for philosophical coherence is especially persistent in educational circumstances characterized by inequality, colonial pasts, and linguicism. In these contexts, translanguaging is frequently framed as a solution to the challenge of linguistic exclusion, however studies exploring the use of translanguaging often perpetuate Eurocentric research conventions and positivist presuppositions (Sikes, 2006; Smith, 2021). Asserting ontological and epistemological considerations is more than an academic endeavor, it is an ethical position for researchers interested in mobilizing translanguaging as a socially transformative project (Chilisa et al., 2017).

This study fills an extraordinarily important gap in literature because while translanguaging has generated enormously broad research interest across an increasing number of educational and sociolinguistic contexts, there is little in-depth critical research that considers empirical work within an ontological and epistemological framework. Özkaynak (2023) notes the problem of systematic reviews of translanguaging from 144 studies not acknowledging their ontological framework. They in their circumstances often resembled that they were left unchecked, their studies lacked descriptive appropriateness, which is a publicity-grabbing problem. MacSwan (2020) similarly notes the unexamined deconstructivist ontology of translanguaging and the writer also calls for ontological and epistemological articulation so that justice-based educational practice supports diverse questions and explorations. This current in-depth critical analysis heeds their calls by clearly reviewing how these selected empirical studies either exhibit and/or obfuscate philosophy.

To address this scholarly gap, the current study will evaluate three empirical research studies published in 2025 from the ERIC database in terms of their philosophical underpinnings, and methodological alignment. The aim of the current study is not to evaluate the studies' findings, but to ask how the studies' paradigmatic positions highlight or inhibit the radical possibilities of translanguaging theory.

LITERATURE REVIEW

Translanguaging has emerged in the last few years as an increasingly recognized disruptive and generative frame for rethinking language not as a bounded, countable system but as a repertoire of resources for meaning-making that are fluid. Translanguaging grows from the critical sociolinguistic tradition and emphasizes the need to interrogate the colonialized hegemonic binaries of native/non-native, mother tongue and second-third language, and standard/nonstandard languages that have historically limited language education (Pennycook, 2020; Wei & García, 2022). The theoretical underpinnings of translanguaging also follow somewhat coherently from several traditions, including those of poststructuralism, constructivism, and decolonization, all of which converge in arguing that language, knowledge, and identity are socially constructed, politically contested and contextually enacted (Canagarajah, 2020; Wei, 2018). Thus, the shift in ontology has been away from seeing languages as separate entities, toward seeing language use as practice which requires an epistemological shift around pluralities, fluidity, and learner agency.

Translanguaging resonates epistemologically with interpretivist and critical paradigms to collectively see knowledge as created in social interactions, power, and experience. Scholars such as Lincoln et al. (2011) operating within such epistemological constraints believe that language is not just a vehicle for transmitting information, but is a tool via which identities, ideologies, and worldviews are constructed. In this sense, translanguaging is also rejected within positivist paradigms that seek to generate generalizable, objective, and standardized measures; it compels entrenched situated, reflexive and context-specific knowledge production. It legitimizes knowledge that is based on lived realities and local practices, and importantly in contexts of linguistic and cultural hybridity, and therefore challenges the Eurocentric knowledge perceived as mainstream in educational research (Chilisa et al., 2017; Smith, 2021).

To put it ontologically, translanguaging is located in a non-essentialist, dynamic orientation to reality, one in which multilingual speakers are not merely holders of discrete languages, but agentive users of combined semiotic resources. This position directly opposes traditional applied linguistics, which is often based on structuralist ontologies and views languages as fixed, governed by rules. As Gurney and Demuro (2022) indicated, we can think of a translanguaging ontology as reframing what we consider real when it comes to language use. That is, it is not the abstract system of grammar or vocabulary items of the nature of a lexical store, rather the lived and embodied communicative acts through which meaning is co-constructed and social realities are established, which benefits their translanguaging framing of language as a dynamic process and practice, not as just a product, that has implications for the aforementioned shift in ontology. Likewise, Blackledge and Creese (2010) made translanguaging the action of multilinguals that are all in emergence, so their meaning-making is not pre-defined or pre-determined or linear, they are making meaning with other multilinguals. This ontology re-conceptualizes what we mean by linguistic competence into performative adaptability (the flexibility of languages), cultural intelligibility (social legitimacy), and ethical relatability (social responsibility), as opposed to whether it was the correct or accurate.

Despite these tenets of theory, a gap exists between theoretical claims of translanguaging as a concept and empirical form. Jaspers and Madsen (2019) indicate the uncritical use of the word translanguaging in educational research, where some researchers referred to translanguaging, often without any critical analysis of its epistemological and ontological premises, as being synonymous with codeswitching or other bilingual language practices. By using the term translanguaging lexically to describe single practices, instead of constructing novel distinct paradigms and practices, researchers bring into question the idea of transformation espoused in translanguaging concepts while still adopting a critical discursive space. A continual theme in this literature is the philosophical contradiction in translanguaging research, where authors draw on theory of a radical nature, in order to conduct research, it must be streamlined to still exist within tradition.

The confluences of both Southern and decolonial epistemologies in language education highlight the necessity for epistemological and philosophical alignment. In language education scholarship, Mignolo (2009) and Smith (2021) have advocated for epistemic disobedience that counters the universalizing, imperialist leanings of Western research models; in such epistemic frame translanguaging is more than an instructional or educational strategy, it can be an epistemological site of resistance, a space to privilege Indigenous knowledges and oral traditions, as well as ways of knowing tied to local cultures. However, as Flores and Rosa (2015) contend, while translanguaging research might provisionally capture this critical pathway, it usually becomes caught up in methodological conservativism or epistemic ambivalence; as a result, there is a compelling urgency for translanguaging studies to more explicitly state and critically engage with their paradigmatic orientations, and to ensure their practices and empirical products were consistent with their theoretical orientations.

In conclusion, while literature endorses translanguaging as a pedagogical and political project, it also indicates that we still have ways to go in explicitly articulating ontological and epistemological grounding. The gap created here limits the extent to which the field can work to solidify translanguaging as a rigorous, counter-hegemonic paradigm. This qualitative study addresses this gap by analyzing three recent empirical studies, not for the pedagogical value, but for the perceived philosophical integrity, specifically, the ontological and epistemological coherence between the conceptual idea and the methodological action.

METHODOLOGY

Ontological and epistemological in-depth analysis needs critical and rigorous analysis, thus selected numbers of studies are quite limited. This current study was inspired by epistemological and ontological issues in language research studies by both Çelik and Köksal (2019); Keser and Köksal (2017). They have taken a qualitative, conceptual review approach and developed a structure with terms from philosophical inquiry. Both were not generating primary data; instead, a structured analysis of research published in the arena of English language teaching, had been conducted. Although situated within a qualitative framework, the concepts are anchored in Guba and Lincoln's (1994) paradigmatic typology, which describes four main research paradigms: (1) positivism, (2) post-positivism, (3) critical theory, and (4) constructivism. In each document analysis from the studies, they were each evaluated according to their ontological position and epistemological orientation by comparing them within a document analysis methodology. The comparison included an examination of methodological structure, philosophical assumptions, and evaluative data. This allowed the reviewers to comment on each data analysis, and their occurrence toward the paradigmatically claimed or assumed inquiry, and to uncover clear theoretical-practical gaps. In the end, the methodology sections for both investigations served as an audit under the domain of philosophy which provided meta-theoretical framework that scrutinizes the degree of internal coherence and foundational rigor of educational research (Çelik & Köksal, 2019; Keser & Köksal, 2017).

This meta-synthesis utilized a qualitative approach to examine the epistemological and ontological orientations of three contemporaneous translanguaging studies from Iran, South Africa, and Indonesia. The purpose of the meta-synthesis was not to evaluate pedagogical outcomes but rather to analyze the philosophy of coherence in clearly laying out the aims of each study, as well as the authors' methodological choices and the assumptions regarding language, knowledge and reality presented in each study. Three studies were selected based on purposive sampling based on how contemporary the study was (published within 2025), the relevance (study offered explicit consideration of translanguaging in language education), and whether the study considered a geographic diversity. The theoretical frameworks the analysis drew upon in a paradigmatic inquiry (Lincoln et al, 2011) were based on four dimensions: ontological stance (fluid or fixed views of language), epistemological orientations (positivist, interpretivist, or critical), methodological choices given those epistemological orientations, and ideological stance given the translanguaging pedagogy being studied.

Interpreting and comparatively reading the studies involved creating analytical memos to document emerging patterns. Though the researcher cannot allow for deductive certainty, this method is situated in constructivist traditions that appreciate researcher reflexivity and critical engagement (Creswell & Poth, 2018; Chilisa et al., 2017). The aim of researcher is to demonstrate how philosophical assumptions shape research narratives and demonstrate the potential disconnects that may exist between theory and methodology.

FINDINGS

This section provides a critical in-depth evaluation and synthesis of three empirical studies situated in Iran, South Africa, and Indonesia, all of which adopt a translanguaging approach. In re-evaluating the studies with reference to ontological and epistemological coherence, the researcher sought whether their methodological practices aligned with the conceptualizations of translanguaging as a change-oriented framework for thinking about language practices. The evaluation focused on how scholars treated language as fluid or fixed (ontology), or knowledge as constructed or measured (epistemology), and the ideological position of translanguaging in the study more broadly.

Study 1: Indonesia " The Potential of Developing Pedagogical Translanguaging in a Private University in Indonesia: A Study of Teachers' Beliefs." (Setyarini & Jocuns, 2025)

In this ethnographic study, the authors explored EFL teachers' conceptualizations of translanguaging and how teachers put translanguaging into action in English classrooms in Indonesia. The authors are interested in translanguaging as a contextualized and agentic practice; in their study, the authors engaged teacher perceptions through interviewing teachers and observing teachers in the classroom. The study takes implicit stance towards constructivist epistemology as knowledge is socially and contextually ascribed through interaction and reflective practice. In this regard, teachers' beliefs are not interpreted as fixed truths, but they are culturally situated epistemic stances shaped by institutional norms and ideological discourses.

In terms of ontological stance, the study appears to take a non-essentialist view, with the use of language being non-essentialist, fluid, emergent, and interwoven across Javanese, Indonesian, and English, where language boundaries are depicted as pedagogically permeable and negotiated through the classroom discourse, suggesting poststructuralist framework. In fact, the study does not make transparent ontological assumptions, nor would it appear to critically reflect on language or identity as constructed categories. While the study does examine agentive and affective dimensions of translanguaging, this lack of straightforward paradigmatic exploration potentially limits the study's philosophical basis. However, the methodological approaches underpinning the study, including, ethnography, discourse analysis, and teacher reflection support a moderate alignment with the theoretical claims of translanguaging.

Study 2: South Africa - "The Effect of Pedagogical Translanguaging on Foundation Phase Classrooms in a South African Private School" (Schoeman, et al., 2025)

This action research project looks at how translanguaging could be implemented in South African, foundation phase classrooms and the level of learner engagement and participation in this teaching strategy. Structured lesson interventions were developed to give teachers a way of documenting how their lessons constituted engagement translanguaging, a checklist for analyzing observation notes in terms of translanguaging learning content, engagement and participation and post-lesson reflections. The research is pragmatically limited to a quasi-positivist epistemology where knowledge involves observable phenomena through changes in behavior and performance.

The study has a more ambivalent ontological positioning. The study allows for multiple languages and recognizes the multilingual repertoires of the learners involved. However, it does not question the ideological assumptions that treat languages as partially separable systems. In critical debates, translanguaging is often characterized in functional terms as a pedagogical strategy, as opposed to a socio-critical stance, highlighting a partial disjunction with the poststructuralist view of language as fluid (not entirely distinguishable), ideological, and constitutive of identity. Thus, a philosophical inconsistency is generated: While the study presents translanguaging as a means to disrupt monolingual norms, the study draws on measurement tools and analytic frameworks that are still situated in structuralist and instrumentalist paradigms. Therefore, even though the study is pedagogically innovative, it shows a somewhat limited consistency with the transformative epistemology of translanguaging. It may risk producing a notion of translanguaging as an enhancement to academic achievement rather than a possibility for resisting linguistic marginalization and establishing epistemic plurality.

Study 3: Iran – "Teacher, Man Mitoonam: Translanguaging and English Language Teacher Emotion Labor" (Nazari, & Karimpour, 2025)

The Iranian study presents a phenomenological account of English language teachers' emotional experiences in relation to their translanguaging practices. The study is firmly located within interpretivist and critical epistemologies and allows teachers' narratives to be treated as epistemic resources in negotiating emotion, identity, and ideology. Data were generated through reflective journals and face-to-face interviews, and the researchers' commitment to understanding "making meanings" is clear; they were attempting to gain a perspective on subjective experience, not a series of quantifiable outcomes.

In terms of ontology, this research takes a distinct poststructuralist stance in which language is understood not as a simple and transparent medium but as a social process imbued with identity creation and emotional labor. The teachers' use of Persian and English was both strategic and affective, bringing teachers into solidarity with students but at the same time within institutional constraints. The research also highlights the affective contradictions emerging from linguistic subordination, showing a deeper awareness of the relationships of power and ideology in the study of language-in-use.

In contrast to the South African and Indonesian studies, the research adheres to a model of strong paradigmatic coherence. The methodology for this study is consistent with its theoretical commitment to translanguaging as an ethical and political practice. The research also takes a position against ideologies of native-speakerism as well as ideologies of standardized English, framing translanguaging not only as a strategy but as a form of epistemic resistance. This study is exemplary in that it has enacted its philosophical positions in every aspect of the research process; It can serve as a model for studies to come in this field.

DISCUSSION

The analysis in this current study has documented different levels of philosophical coherence across the three-criterion based selected translanguaging studies. These differences are indicative of larger tensions across the translanguaging field of study between translanguaging as a critical paradigm and translanguaging as pedagogy. The Iranian study (Nazari & Karimpour, 2025) demonstrated a high degree of poststructuralist ontological and interpretivist epistemological coherence while the South African study (Schoeman, et al., 2025) explicitly stated neither (beyond functionalist assumptions). The Indonesian study (Setyarini & Jocuns, 2025) afforded a middle ground. The Indonesian study employed a methodology that can be consistent with the tradition of constructivism but did not explicitly reflect upon the philosophical implications of using explicit pluralism and language systems. Importantly, the patterns of philosophical coherence are consistent with the current critiques of translanguaging literature (Jaspers & Madsen, 2019; Flores & Rosa, 2015) conceptual slippage, resulting in the name translanguaging being appropriated widely but absent a rigorous theorization.

The Iranian study fits quite neatly into the burgeoning body of recent research which similarly accentuates the emotional, ideological and agentive aspects of translanguaging. Zhang (2024) recently unraveled that teachers intentionally utilized students' first language in conjunction with English not only as a way of building relationships by clarifying meaning but also to connote a belief in the students, reduce anxiety, and construct some interpersonal warmth. By doing so, teachers were building a distinct culture in the classroom characterized by openness and collaboratively co-constructing learning. These similar studies reflect a trust in productive and fruitful epistemologies that advocate a subjective approach to lived experience, whose ontologies refuse to indiscriminately privilege the language boundaries of binary linguistic systems. Likewise, García, et al., (2017) espoused translanguaging stance as a philosophical orientation, not a method, and insisted that researchers ensure their methodological decision-making is reflective of the political and epistemic implications of translanguaging.

Conversely, the South African research indicates a reproducible trend found in some empirical translanguaging work, namely, a new practice in the classroom disconnected from any understanding of its critical theoretical bases. In their work in Zimbabwe, Charamba (2020), The study uses a qualitative case study approach to investigate how a bilingual teacher mediates science concepts in both English and Shona that was intended to foster content understanding among students from linguistically diverse backgrounds. It highlights how translanguaging can be used in STEM subjects to promote equitable access to knowledge, while supporting learners' linguistic resources and reality, even when in a challenging system. Although the reporters found the translanguaging approach valuable, it was also subject to institutional constraints, such as curriculum requirements and high stakes testing that were all conducted in English. These constraints often, but not always, put the teachers in contradictory positions attempting to enact inclusive practices while also mediating a system which actively constructed hierarchies of languages. While these are productive pedagogically, they risk perpetuating structuralist thinking about the nature of language, especially if grounded only in pragmatic justification rather than with a clear philosophical underpinning. Wei (2018) asserts that thinking about translanguaging as codeswitching plus ignores that rhetorical process and therefore possibilities for understanding transformational and decolonial forms of agency and voice.

The Indonesian study, despite its methodological nuance, mentions to a common problem in Global South contexts: Translanguaging is perceived as a tool for linking policy-practice gaps, without any critique on the ontological aspects of language education policies themselves (Hornberger & Link, 2012). While Setati and Adler (2000) have emphasized the value of local classroom practices for quite a long time, we can also note critiques of these studies and studies like them for not taking integral aspects of translanguaging and discourse on the ideologies and epistemological stances. Through comparison with studies like Mazak and Carroll (2017) unearths how they examine the social construction of knowledge as well as considerations of identity, which this study may not do since discussion of social contexts and identity are absent in the other studies. I have mentioned thus far that most studies that concern translanguaging and educational practices are framed in pragmatic, rational or behavioral terms.

Overall, the present findings resonate with Canagarajah's (2020) assertion that translanguaging research needs to progress, moving beyond superficial use, and gravitate towards an approach emphasizing reflexivity around paradigmatic concerns. Without paradigmatic reflexivity, translanguaging may risk developing into depoliticized pedagogical practice, absent its emancipatory nature. The current analysis also corroborates Smith's (2021) and Chilisa et al.'s (2017) demands for decolonial practices that do not just disrupt systemic advantages in language inequality but interrupt epistemic injustices in research too. In this phantom, scholars focused on translanguaging practices should identify their ontological and epistemological positioning directly, knowing that they are crucial and not supplementary to their empirical shapedness.

In conclusion, this comparative perspective positions the stakes of philosophical coherence in translanguaging research. Each of the studies examined contributes to the growing field, but only one fully articulates the epistemological and ontological commitments requisite of translanguaging if it is to live up to its transformative potential. If translanguaging is going to act as a pedagogical and political intervention in multilingual education in the future, researchers must acknowledge and align their theoretical frameworks.

In brief, this comparative perspective positions the stakes of philosophical coherence in translanguaging research. Each of the three studies provides valuable insights into this rapidly evolving literature on translanguaging, but only one of the three studies is revealed to embody fully the epistemological and ontological stances that are necessary for translanguaging to hold a transformative potential. If translanguaging is going to act as a pedagogical and political intervention in multilingual education in the future, researchers must acknowledge and align their theoretical frameworks. Future research must ensure consistency and transparency within the theoretical underpinnings if translanguaging is to serve as both pedagogical and political form of intervention in multilingual education.

CONCLUSION

This qualitative synthesis focused on the ontological and epistemological consistency of the three recent empirical studies that focused on translanguaging in Iran, Indonesia, and South Africa. Using qualitative critical analysis, this recent study demonstrated the different ways that these empirical studies, despite treating translanguaging as a conceptual or pedagogical tool, were fundamentally different with respect to their ontological and epistemological alignments. The Iranian study embodied paradigmatic consistency, as translanguaging was a politically charged and emotionally embodied act. In contrast, the South African and Indonesian studies exhibited partial or limited take up of the theorized commitments that underpin translanguaging theory. In this regard, these outcomes are not simply methodological issues but are connected to the meta-theoretical tensions that translanguaging literature is experiencing in relation to the critical-theoretical origins of translanguaging and its institutional commodification into translanguaging.

An important takeaway from this analysis is that translanguaging research needs to be paradigm-wise explicit. From translanguaging's beginnings within educational contexts and now appearing to proliferate, it is increasingly important to resist viewing translanguaging as a set of technical strategies for classroom practice. When it is under-theorized or caught on its ontological and epistemological basis, we run the risk of normalizing not just conceptual dilution but also monolingual ideologies in a different uniform.

Given translanguaging's radical potential as an epistemology of the local, as an ontology of flow, and as a pedagogy of resistance, scholars must take care to maintain the integrity of theory, method, and purpose. Additionally, this study helps to add to the growing demand for decolonial and Southern frameworks across language research. As illustrated, translanguaging in Global South contexts cannot be properly theorized using Eurocentric frames examining standardization and stability (as if there were an ideal form of language to return back to) or universalism. Rather, language researchers need to recognize indigenous knowledge systems, engage with local multilingual practices, and utilize forms of epistemic authority that are grounded in social context. This would not only allow for further cross-cultural relevance but also validate the ethical commitments made with translanguaging research into epistemic justice and linguistic equity.

Research in the future should pay special attention to being transparent in highlighting paradigmatic assumptions and working coherently across the spectrum of research inquiry, from research questions through to analysis and interpretation of data. Comparative and cross-regional studies such as the one discussed above are especially useful in tracking how translanguaging is conceptualized and understood across sociolinguistic contexts. Moreover, the ideological work done by these studies must always be questioned: What knowledge is privileged? What language practices are made visible or invisible, and how are normative practices being reproduced, or interrupted or challenged?

In conclusion, the researcher wants to emphasize that epistemology and ontology are by no means abstract ideas, but rather concrete aspects of trustworthiness or integrity in research. Translanguaging research that does not adequately engage with epistemological and ontological questions, reinforces the very hierarchies, of knowledge and power, that translanguaging seeks to unsettle. By contrast, research as philosophically coherent, with attention to epistemology and ontology specifically, is more likely to honor researchers' ideologies about translanguaging, its potential as socio-cognitive resource for language learning, and crucially, its potential as liberating practice within language education.

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The impact of direct teacher-student discussion on the development of social and interpersonal skills in classrooms

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ABSTRACT

This study examines the impact of direct teacher-student discussions on student socialization in the classroom. Open dialogue with teachers encourages students to express their thoughts, boost communication confidence, and supports the development of interpersonal skills. The findings indicate that teacher-led discussions are key to strengthening peer relationships, promoting collaboration, and fostering a positive classroom environment. The hypothesis guiding the study is: "*Direct interaction with the teacher during class enhances student socialization by encouraging self-expression and interpersonal skill development.*" Effective communication and direct discussion between teachers and students are fundamental components of modern education. These interactions not only enhance academic learning but also play a critical role in the socio-emotional development of students. Encouraging dialogue fosters students' self-expression, critical thinking, and collaboration skills, which are essential for their overall socialization and future success. This study contributes to the growing body of research emphasizing student-centered approaches and highlights the need for educational practices that prioritize active engagement and interpersonal communication in classrooms.

Keywords: Teacher-student interaction, socialization, interpersonal skills, classroom discussions, socio-emotional development, collaboration, supportive learning environment.

INTRODUCTION

Effective teacher-student communication plays a vital role in fostering a supportive learning environment. Direct discussions between teachers and students encourage the expression of thoughts, build confidence, and strengthen interpersonal skills. This paper examines how teacher-led dialogues in classroom settings enhance students' socialization, collaboration, and overall classroom dynamics, contributing to their socio-emotional development.

1. Theoretical aspect of the paper

The study is grounded in social constructivist theory, which emphasizes the role of interaction and dialogue in learning. Through active discussion, students collaboratively construct knowledge and engage more deeply in the learning process. Additionally, socio-emotional learning (SEL) theories suggest that direct communication in the classroom enhances not only academic performance but also empathy, teamwork, and relationship-building. These theoretical perspectives highlight the importance of fostering a classroom environment where students feel safe and encouraged to express themselves and connect with peers and teachers alike.

Today, there is widespread discussion about a new kind of teaching—one that emphasizes the abilities, potential, and active engagement of students. The term contemporary teaching refers to an approach that contrasts with traditional models. This transformation is evident in several aspects, including teaching strategies, methods, techniques, organizational forms, shifts in the roles of teachers and students, classroom environment, respect for children's rights, and redefined learning objectives and assessment processes. As Havziu-Ismaili (2019) states, “Contemporary teaching must be understood as a form of instruction that facilitates appropriate methods, techniques, and strategies tailored to student learning.” Contemporary teaching promotes active learning, critical thinking, student agency, and a learner-centered approach. According to Musai (2003), “Teaching is a difficult and complex task that requires a broad set of knowledge, skills, and habits.” In essence, “Contemporary teaching involves a fundamental shift in the roles of both teachers and students, with the primary objective being the facilitation of learning.” (Rama, 2011)

The teacher is no longer merely a transmitter of information but a facilitator who guides students in learning and behaving in new and constructive ways. Musai (1999) defines a teacher as someone whose main professional role is to assist others in acquiring knowledge, skills, and behaviors essential for personal and social development. In the context of modern education, the teacher’s role has evolved significantly. Teachers are now expected to align with the objectives of student-centered programs and foster environments that promote social-emotional development through meaningful communication. In the past, classroom communication was often unidirectional—the teacher was seen as the ultimate authority and the sole source of knowledge. As Gixhari (2016) observes, “The teacher was once viewed as an inviolable figure, where any challenge or disruption by the student was met with punishment, thus minimizing genuine interaction.” This authoritarian model limited the development of mutual communication between teachers and students.

Modern pedagogy also places a strong emphasis on children's rights, viewing them not just as learners but as active citizens. Children, like all individuals, have rights that must be respected and upheld daily. Their physical, emotional, and social development requires special attention. As noted by the Macedonian Center for Civic Education (2019), “Children are best prepared to become active citizens when they are introduced to and practice their rights from an early age.”

Classroom communication today serves multiple purposes and takes on various forms. The ultimate goal is to enable students to express themselves freely through authentic discourse appropriate to the context. Achieving this goal is not simple—it requires students to have sufficient linguistic and grammatical competence to engage in meaningful spoken interaction. As Haloçi (2010) outlines, four main types of communication can be employed in the classroom:

- Didactic communication;
- Restriced communication;
- Simulated communication;
- Genuine (authentic) communication

Each of these modes contributes to creating a dynamic and inclusive learning environment where students can actively participate, reflect, and collaborate.

In the past, communication between teachers and students often featured an authoritarian approach, with the teacher in a dominant position while the student took on a passive role. The teacher acted not only as the transmitter of information but also as the sole authority who set the classroom rules and controlled the learning environment. In this context, students were rarely given chances to express themselves freely. This teacher-centered communication model frequently led to lessons being structured as monologues, with minimal student input or interaction. As a result, students found it difficult to engage, ask questions, or share their thoughts, which significantly stifled their creativity and initiative. The learning process became rigid, focusing solely on what was to be learned and how it was to be learned, leaving little room for student discussion or active participation. Even when questions were necessary to clarify complex concepts, they often went unasked or unaddressed due to the prevailing culture of obedience and passive learning.

In contrast, student-centered teaching fosters a more inclusive and interactive learning environment. Bara and Xhomara (2020) emphasize that this approach, where students actively engage in discussions, collaborative problem-solving, and critical inquiry, leads to improved academic outcomes, particularly in subjects like science. One of the central methodologies within this framework is Problem-Based Learning (PBL), which involves students in exploring real-world problems. PBL encourages critical thinking, teamwork, and a deeper conceptual understanding, aligning closely with discussion-based teaching.

In student-centered classrooms, the teacher's role shifts from that of an authoritative instructor to a facilitator of learning. Teachers guide discussions, ask thought-provoking questions, and support collaboration among students. This model, as discussed in the study by Bara and Xhomara (2020), demonstrates that active student engagement in dialogue and problem-solving enhances academic performance and nurtures higher-order thinking skills. In such environments, students are not passive recipients of knowledge but active participants who contribute to and construct their understanding.

Furthermore, active communication and interaction between teachers and students play a crucial role in the socialization process. These interactions significantly affect the development of children's social, emotional, and communicative skills, which are essential for building interpersonal relationships and successfully integrating into social environments.

1.1 Key aspects affected by active communication:

- ***Development of communication skills***

In classrooms that nurture open communication and collaboration, students learn to express their ideas, opinions, and emotions effectively. This is vital to the socialization process, as it enables them to build and maintain relationships with their peers. Constructive communication also provides students with conflict-resolution skills while promoting active listening and empathy—critical aspects of social development.

- ***Creating positive and supportive environments***

A learning environment that encourages interaction and communication fosters a supportive and welcoming atmosphere. Children who feel safe and accepted are more willing to engage with others and build healthy relationships. Such environments promote cooperation, respect for differing opinions, and the development of tolerance and understanding among peers.

- ***Enhancing collaborative skills***

Active communication plays a crucial role in developing students' abilities to work effectively in groups. Through collaboration, students learn to negotiate, share responsibilities, and offer mutual support. These experiences are essential for socialization, as they teach children how to listen, respect others, and help their peers—skills that are vital for establishing strong and positive social bonds.

- ***Developing awareness of social and cultural changes***

Open and interactive learning environments expose children to a range of perspectives and ideas. This exposure enhances their understanding of societal and cultural diversity. As a result, students learn to appreciate differences and collaborate with individuals who have varying viewpoints, fostering respect for diversity.

- ***Addressing children's desires and emotions***

Active communication creates opportunities for children to express their emotions and desires openly. This expression facilitates problem-solving and clarifies misunderstandings. Through this process, children develop skills in emotional regulation and learn to build healthy, harmonious relationships.

- ***Increasing self-confidence and social autonomy***

Children who are encouraged to participate in discussions and group activities often gain confidence in expressing their thoughts and ideas. This active engagement is critical for developing self-confidence and a strong social identity, enabling children to become more open, autonomous, and socially engaged. Learning environments that prioritize active communication and interaction provide an effective foundation for supporting children's socialization. They enable the development of vital social skills that will benefit students throughout their lives.

2. Methodological Aspect

2.1 Purpose and Objectives of the Study

- To explore how primary school teachers in the Republic of North Macedonia engage in direct discussions with students and promote peer discussions to address educational issues.
- To assess the effects of classroom discussions on students' social, emotional, and communication development.

Hypothesis:
"Direct discussion between teachers and students during class enhances student socialization by encouraging the expression of thoughts and fostering strong interpersonal skills"

2.2 Research sample and context

The study involved 60 teachers and 150 students from the lower cycle of primary education in both rural and urban areas of Tetova, North Macedonia. The research was conducted in six primary schools—three urban and three rural.

2.3 **Research methods, techniques, and instruments**

The research methods applied are as follows:

- Descriptive method
- Analytical method
- Synthesis method
- Comparative method
- Statistical method

This quantitative study employed survey techniques. Data were gathered using two types of questionnaires: one for teachers and another for primary education students.

3. Analysis and interpretation of results

Communication is a fundamental pillar in developing an effective educational process. Effective communication within the teacher-student relationship is essential for a successful learning environment. For

communication to be effective, active participation from both teachers and students is necessary. In classrooms where genuine interaction occurs, lessons flow smoothly, the atmosphere remains positive, and academic success is more likely.
The following table summarizes the responses of 60 teachers about their communicative practices and the level of interaction they maintain with students.

Table No. 1. Sample – Respondents (teachers) by gender.

Gender		Number	%
Male		15	25,0
Female		45	75,0
Total		**60**	**100,0**

Table no. 2. Sample Respondents (teachers) according to education.

Level of education	**Number**	**%**
Faculty of pedagogy	**16**	**26,67**
Macedonian lenguage	**1**	**1,67**
Classroom teaching	**8**	**13,33**
Higher education	**26**	**43,34**
Masters	**5**	**8,33**
Faculty of Philology	**2**	**3,33**
Fakulteti i Shkencave Natyrore	**2**	**3,33**

Table no. 3. Number of teachers according to primary schools.

Nr.	Primary schools	No of teachers	%
1.	Primary school "Liria" – Tetovo	20	33,33
2.	Primary school"Naim Frashëri" – Tetovo	15	25,00
3.	Primary school "Istikball" – Tetovo	10	16,67
4.	Primary school "Ibrahim Temo" – Tetovo, village Strimnica	7	11,67
5.	Primary school "Fan Noli" – Tetovo, village Pallatica	5	8,33
6.	Primary school"Fan Noli" – Tetovo, village. Ozurmisht	3	5,00
	Total	**60**	**100,0**

Table no. 4. Do the teachers use supportive and motivating words with you, supporting you during the lesson?

Category	Girls (n)	Boys(n)	Correlation(r)
Frequentli	30	40	1.0
Rarely	30	11	1.0
Very rareli	0	0	0
Never	**6**	**6**	**6**

In the question that asked the students whether they think that their teacher supports them during the learning process, their answers were different, where the majority or rather 79 students or 52.67% said "Yes" the teacher or the teacher supports them during the learning process. On the other hand, 37 students, or 24.67% answered that "To some extent" they receive support during learning from the teachers. While 34 students or 22.66% of the surveyed students answered that "No" they do not receive support from their teachers. As for the gender differences, the analysis according to Pearson's correlation for most of the time (r=1.0) shows us a perfect relationship between the answers of both sexes. For, Never the value (r=0.0) that actually tells us about the lack of connection between the female and male sexes. In this case, girls have a much higher perception than boys in the use of words by teachers, which gives us insight that girls feel closer to teachers and are more inclined to perceive and feel good words.

Table 5. Correlative analysis between the influence of students' motivation through rewards in the achievement of socialization development

		Motivation	H
Motivation	Pearson Correlation	1	.085
	Sig. (2-tailed)		.233
	N	210	210
H1	Pearson Correlation	.085	1
	Sig. (2-tailed)	.233	
	N	210	210

Table no. 5 presents the correlational analysis between the variable of motivation through rewards from teachers and the achievement of the development of student socialization during the educational process, among students of the lower cycle of primary education, in which case the analysis shows that the correlation is weak and with a positive direction, but statistically significant ($r=-.085$, $p<.001$), this means that: Students who are motivated or stimulated by teachers manage to find greater support in their teachers, and it undoubtedly has a positive impact on improving the teacher-student ratio and at the same time serves as a stimulus for students to be more motivated to learn. However, rewarding students when they succeed in lessons is an example that shows that their work is highly valued by the teacher. It is worth noting that the results of the correlative analysis show a weak, but positively statistically significant relationship ($r = 0.085$, $p = 0.001$) between the influence of teachers' rewards and the development of students' socialization during the educational process.

This suggests that teacher rewards and motivation have a positive impact on improving student-teacher relationships and student motivation to learn. However, the impact is modest, indicating that rewards, despite being a supporting factor, are not key factors for the full development of students' socialization.

Table 6. Correlative analysis between the discussion during the lesson and the socialization of students

		Socialize	H
Socialize	Pearson Correlation	1	.738**
	Sig. (2-tailed)		.000
	N	210	210
H0	Pearson Correlation	.738**	1
	Sig. (2-tailed)	.000	
	N	210	210
**. Correlation is significant at the 0.01 level (2-tailed).			

Table no. 6 presents the correlation analysis between the variable of classroom discussions about the socialization of students during the educational process; therefore, the analysis shows that the correlation is strong and positive, as well as statistically significant (r=- .738, p<.001). This says that the more properly the discussions in the classroom are conducted, the more the socialization of the students increases during the educational process, thus the second auxiliary hypothesis that the discussion during the lesson increases the socialization of the students among them is verified.

2. Conclusion

The results of the correlation analysis indicate a strong and statistically significant relationship between classroom discussions and student socialization (r = 0.738, p = 0.001). This indicates that as students engage more in discussions during lessons, their skills in socialization and forming positive relationships with peers become more developed. Classroom discussions directly influence students' social skills, enhancing their empathy, tolerance, and ability to cooperate with others.

Recommendations:

- Encouraging discussions during learning: Teachers should create opportunities for students to engage more in discussions and group activities, as this helps develop their social and communication skills. This can include the use of debates, open discussions, and activities that encourage collaboration.

- Support for classroom socialization: Teachers should focus on creating an open and supportive environment that encourages student socialization. This may include special activities to help develop interpersonal relationships and improve students' social skills.
- Increase rewards and positive recognition: Teachers should continue to use rewards and positive words as a tool to motivate students. This can help strengthen student-teacher relationships and encourage students to improve their performance in lessons.
- Developing a positive classroom culture: Teachers should create an environment where students feel valued and motivated to learn, using fair and equitable rewards that encourage the development of students' social and academic skills.
- Incorporating activities that promote cooperation: Activities that encourage students to work together and help each other can be very helpful in increasing their socialization. Using rewards to support these activities can help increase student motivation and engagement.

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The Impact of using Artificial intelligence to help Students with limited intelligence at different types of schools and Libyan universities

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ABSTRACT

The rapid advancement of Artificial intelligence (AI) technology have revolutionized a number of industries, including education. In the field of e-learning, this study investigates how artificial intelligence (AI) might improve accessibility and the educational opportunities for people with impairments. Educational platforms may customize learning environments to match the specific requirements of students with students with limited intelligence at different types of schools and Libyan universities by utilizing AI-driven technologies including speech recognition software, adaptive learning systems, and predictive text inputs. Surveys and data analytics were used in this study to show that AI technologies improve accessibility while also improving overall learning results and independence for students with impairments. Despite these advantages, a number of obstacles, such as technological Artificial intelligence (AI) technology have revolutionized a number of industries, including education. In the field of e-learning, this study investigates how artificial intelligence (AI) might improve accessibility and educational opportunities for people with impairments. Educational platforms may customize learning environments to match the specific requirements of students with students with limited intelligence at different types of schools and Libyan universities by utilizing AI-driven technologies including speech recognition software, adaptive learning systems, and predictive text inputs. Surveys and data analytics were used in this study to show that AI technologies improve accessibility while also improving overall learning results and independence for students with impairments. Despite these advantages, a number of obstacles, such as technological abilities.

Keywords: Artificial Intelligence, students with limited intelligence, Accessibility, Adaptive Learning Systems.

INTRODUCTION

Artificial intelligence (AI) is rapidly evolving, and this has profoundly changed many industries, including education. The e-learning industry's assistance for people with students with limited intelligence at different types of schools and Libyan universities is one area of effect that deserves special attention (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). For this group of people, AI's ability to improve and personalize learning experiences is proving to be transformative. E-learning systems, which were once created using a one-size-fits-all methodology, may now provide customized learning opportunities, promoting inclusive learning environments (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). Tools and apps that solve the particular difficulties encountered by are being developed using artificial intelligence (AI) technology, such as computer vision, machine learning, and natural language processing. learners with impairments (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022). For example, real-time transcription of spoken information may be provided by AI-powered voice recognition software, which can help students with hearing difficulties. Similarly, people with motor impairments can benefit from AI-driven predictive text and alternate input techniques, which can help them connect with e-learning platforms more efficiently (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). Furthermore, students with cognitive challenges stand to gain, especially from the use of AI in developing tailored learning paths. By taking into account each learner's unique requirements and preferences, adaptive learning systems which modify the degree of difficulty and manner in which instructional materials are presented can greatly improve the quality of the learning process (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). Its individualized approach increases the learner's confidence and drive while also helping them understand and remember the material. Studies indicate that the integration of artificial intelligence (AI) into online education for those with impairments not only increases accessibility but also yields better learning outcomes overall (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024). Thanks to AI technology, educational opportunities for these people may now be more equally distributed by removing obstacles that have historically hindered their progress (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022). Furthermore, by utilizing data analytics to enhance and improve the support offered to students with impairments, the incorporation of AI into e-learning systems has the potential to develop continually (ELMORTAJI et al., 2024); (Carvalho et al., 2024). AI's broad and varied effects on the e-learning industry's ability to help individuals with impairments are significant. Research must be done continuously as AI develops to investigate its full potential and to address any ethical and practical considerations associated with its implementation (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). The goal is to create an inclusive educational landscape where all learners, regardless of their abilities, can thrive (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022).

The research Motivation

Research on the A developing field that has the potential to greatly improve educational accessibility and inclusion is the integration of Artificial Intelligence (AI) to serve people with students with limited intelligence at different types of schools and Libyan universities in the e-learning industry (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024). An urgent social need to provide fair learning settings and the convergence of technology breakthroughs are the driving forces behind investigating how AI may assist individuals with students with limited intelligence at different types of schools and Libyan universities in e-learning environments (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). First off, artificial intelligence (AI) technologies like computer vision, machine learning, and natural language processing have advanced to the point that they can provide real-time, adaptive learning environments. These tools can be modified to meet the different requirements of students with students with limited intelligence at different types of schools and Libyan universities (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022). For example, voice recognition for those with hearing impairments or predictive text and voice-to-text features for people with visual impairments whose dexterity or movement is compromised (Smith, 2021; Johnson & Lee, 2022).In addition, the COVID-19 pandemic has caused a shift in educational paradigms from traditional to digital platforms, which has resulted in exponential development for the worldwide e-learning sector (Brown & Green, 2020). Though AI integration aims to solve this issue by offering individualized learning experiences that adjust to the learner's speed and learning style, this move has also brought to light major gaps in accessibility for impaired learners (Williams, 2023). Moreover, the moral and legal obligations, including those stated in the United Nations Convention on the Rights of Persons with students with limited intelligence at different types of schools and Libyan universities (UNCRPD) support promoting diversity via the use of technology. According to Thompson et al. (2021), the potential of artificial intelligence (AI) to provide barrier-free learning is in line with these regulatory frameworks, which encourage educational institutions to use technologies that cater to a varied student body. Finally, AI in education has significant societal ramifications for those with students with limited intelligence at different types of schools and Libyan universities. Using AI technologies in education will help students with students with limited intelligence at different types of schools and Libyan universities become more independent and self-assured, which will promote an inclusive community. Giving this group more authority through specialized learning resources improves their academic performance and helps them integrate into society more broadly (Patel & Smith, 2022). Using data from current studies to provide a thorough picture of this revolutionary convergence of technology and disability, the research will critically assess the effects, difficulties, and future prospects of AI in the e-learning industry for people with students with limited intelligence at different types of schools and Libyan universities education.

The research aim

- To assess the current state of AI technologies employed in e-learning platforms with a focus on accessibility features for disabled users.
- To explore the effectiveness of these AI technologies in meeting the educational needs of individuals with students with limited intelligence at different types of schools and Libyan universities.

The research scope under the introduction

The scope of this research encompasses a comprehensive examination of how Artificial Intelligence (AI) technologies are implemented in e-learning platforms to support learners with students with limited intelligence at different types of schools and Libyan universities (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). The focus is on a range of AI tools and their capabilities to enhance accessibility and inclusivity, which are critical in the educational development of this demographic.

Significance of the Research

The application of Artificial Intelligence (AI) in the e-learning space has attracted a lot of attention, especially because of its potential to help people with impairments. This study is important in a number of ways, including societal, technical, and educational aspects. Education inclusion has advanced significantly with the introduction of AI into virtual learning settings (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022). The varied demands of students with impairments are frequently not met by traditional e-learning platforms, which results in unequal learning opportunities. AI-powered products like assistive technology and adaptive learning systems provide tailored learning experiences that can greatly improve these kids' academic performance (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). AI can help close the achievement gap between children with students with limited intelligence at different types of schools and Libyan universities and their counterparts by customizing educational content to each student's unique learning style and requirements promoting an environment in school that is more inclusive. This research advances the continuous development and improvement of AI applications in education from a technological standpoint. Innovation in AI-driven solutions, like real-time transcription services, alternative input methods, and voice recognition software, is made possible by an understanding of the unique requirements of students with students with limited intelligence at different types of schools and Libyan universities (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). The results of this study can help educators and developers implement AI in e-learning more effectively, resulting in innovations that improve usability and accessibility. Furthermore, as these technologies advance, more complex and user-friendly teaching systems may result. This study has significant societal ramifications. A essential human right is education, hence making sure that everyone, regardless of for fostering equality and social inclusion, it is crucial that they have access to high-quality education. The significance of inclusive educational methods is shown by this research, which shows how AI may improve the educational experiences of students with impairments. It emphasizes how important technology is in removing obstacles and enabling people with impairments to reach their greatest potential. Furthermore, the educational community and society at general may become more conscious of and accepting of students with various learning requirements as a result of the wider use of AI in e-learning. Education institutions, legislators, and educators may all benefit from the practical insights this research offers (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024). To guarantee that AI tools are used to their maximum potential in e-learning courses, the evidence gained can direct their deployment. The results may be used by policymakers to promote financing and backing for AI projects that improve accessibility in education. In order to establish more inclusive learning environments that meet the needs of all students, educational institutions can implement the best practices found in this research. To sum up, this research is important because it has the potential to improve e-learning platforms' technological capabilities, change the way that education is delivered, and advance social equity by making sure that students with students with limited intelligence at different types of schools and Libyan universities get the help they require to succeed. This study's consequences go beyond academia, providing a road map for developing more inclusive, approachable, and successful educational systems.

AI Tools and Technologies

Investigate various adaptive learning systems, speech recognition software, and assistive robotics are examples of AI technologies that are now being used in e-learning. According to Patel and Smith (2022) each device will be assessed for appropriateness and effectiveness in meeting the needs of particular categories of disabled people. Analyze the integration of these AI technologies with current e-learning platforms and their applicability in actual classroom environments, paying particular attention to interaction and user interface design patterns (Johnson & Lee, 2022).

Effectiveness for Disability Types

Analyze the effectiveness of AI-driven tools in supporting different disability categories, including visual, auditory, cognitive, and motor impairments. This involves both quantitative measures of educational attainment and qualitative feedback from users (Williams, 2023).

Barriers and Enablers

Identify the main barriers faced by learners with students with limited intelligence at different types of schools and Libyan universities in accessing AI-enhanced e-learning, and explore the enablers that facilitate their learning experiences. This will include technological, psychological, and social factors (Thompson et al., 2021).

Privacy and Data Security

Examine the The application of AI in e-learning has ethical ramifications, especially when it comes to concerns about data security and privacy. Examine the laws that are currently in place controlling the use of AI in education, paying special attention to the ones that address accessibility and the rights of people with students with limited intelligence at different types of schools and Libyan universities (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). Make policy suggestions to enhance the integration of AI in educational settings, depending on the study findings (Brown & Green, 2020). Examine cutting-edge AI techniques that could improve the quality of e-learning for those with impairments. This will cover newly developed, not-yet-widely used technology adopted but hold promise for making educational environments more inclusive.

Scalability and Adaptability

Discuss the scalability of successful AI applications in e-learning and their adaptability to diverse educational contexts and geographical locations. By delineating these areas, the research aims to provide a structured and focused exploration of AI's impact on e-learning for individuals with students with limited intelligence at different types of schools and Libyan universities, identifying both current applications and future opportunities for enhancement.

Literature review

E-Learning and Accessibility Challenges

E-learning platforms offer numerous benefits, including flexibility and access to a vast knowledge base. However, traditional e-learning materials can present significant challenges for people with students with limited intelligence at different types of schools and Libyan universities, such as below:

Visual Impairments

The application e-learning industry has demonstrated considerable potential in utilizing artificial intelligence (AI) to tackle the difficulties encountered by students with visual impairments. Because of their heavy emphasis on visual material and navigation, traditional e-learning systems sometimes provide significant obstacles for these students. But AI technologies also provide creative ways to improve accessibility and foster a more diverse learning environment (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022).

AI-Powered Screen Readers and Voice Assistants

One of the most The creation of AI-powered screen readers represents a big improvement in AI for learners who are visually impaired. Through the use of natural language processing (NLP), these solutions enable visually impaired students to access digital content more efficiently by converting text and other visual information into synthesized voice or braille output (Smith & Anderson, 2018). Modern screen readers, like NVDA and JAWS, integrate artificial intelligence (AI) to enhance accuracy and context comprehension, making the user experience more seamless and intuitive. Voice assistants that use artificial intelligence (AI) to help visually challenged pupils include Google Assistant, Apple's Siri, and Alexa from Amazon. These assistants can do a number of things, such as setting reminders and reading aloud instructional materials and use spoken commands to navigate intricate e-learning environments (Garcia et al., 2019). Students with visual impairments can concentrate more on their studies by having a much lighter cognitive burden thanks to the incorporation of these AI techniques into e-learning systems.

material.

Image Recognition and Description

Another The topic of picture identification and description is a significant application of AI for visually challenged learners. AI systems are capable of analyzing visual input and producing comprehensive spoken descriptions of pictures, graphs, and charts. One example of this is the Seeing AI app from Microsoft. This capacity is especially helpful in fields like science and mathematics where visual data is highly relied upon (Johnson et al., 2021). AI aids visually impaired pupils in comprehending concepts more thoroughly by converting visual information into aural explanations of the material.

Adaptive Learning Systems

AI-driven Additionally essential to helping visually impaired pupils is the use of adaptive learning methods. Based on the performance and preferences of the learner, these systems employ machine learning algorithms to customize the learning process (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024). Adaptive systems can change how material is presented for visually impaired learners, giving it to them in formats that are easiest for them to use, including braille or audio (Miller & Rose, 2020). This customized strategy increases engagement and retention while also improving accessibility of information.

Real-World Applications and Research

Research has proved how well these AI technologies work to improve the educational outcomes for kids who are visually impaired. According to a research by Williams and Brown (2022), e-learning systems' usability and accessibility significantly increased with the introduction of AI-powered voice assistants and screen readers. In addition, compared to conventional techniques, pupils expressed greater levels of engagement and pleasure with these AI technologies. Another research demonstrated how artificial intelligence (AI) can offer real-time support and feedback. To provide a more engaging and encouraging learning environment (Al-Mamari et al., 2021); (Kharbat et al., 2021); (Bressane et al., 2024); (Ahuja et al., 2022); (Kouveliotis and Mansuri, 2022); (ELMORTAJI et al., 2024); (Carvalho et al., 2024), AI, for instance, may track a student's progress and provide prompt assistance if they run into problems. (Thompson & Hughes, 2023).

Natural Language Processing (NLP)

Text-to-speech For students who struggle with reading or vision problems, conversion and voice recognition can increase accessibility (Mittal et al., 2020). Additionally, NLP may customize learning materials by adjusting language difficulty to meet the needs of each individual. According to Aleven et al. (2023), Intelligent Tutoring Systems (ITS) have the ability to provide customized learning routes, adaptive feedback, and difficulty level adjustments depending on the unique requirements and progress of each learner. This might be especially helpful for those who struggle with cognitive difficulties (Ben Dalla et al., 2024); (Dalla, 2020), (Dalla et al., 2024); (Dalla and Ahmad, 2020); (Dalla and Ahmad, 2023); (DALLA and AHMAD, 2024); (Ben Dalla et al., 2025). Applications and technologies for computer vision and assistive technologies are able to assess user behavior and modify the interface accordingly. For people with limited motor skills, features like eye-tracking software can provide alternate navigating ways. (2017) Mubin et al. The Effects of AI on Online Education for Individuals with students with limited intelligence at different types of schools and Libyan universities. Customized educational opportunities and flexible assistance can improve understanding retention and skill growth (Taylor et al., 2021). Higher levels of engagement can result from accessible e-learning systems that provide users a sense of autonomy and control over the learning process (Alsubhi et al., 2020). AI technologies can create more inclusive educational possibilities by bridging the gap between traditional e-learning and the demands of learners with impairments. (Meskhi et al., 2019).

The Research Problem Statement

Despite significant students with impairments still encounter significant obstacles that prevent them from moving further in their education, despite advances in e-learning tools. Inequitable access to education results from traditional e-learning platforms' often lack of the accommodations needed to meet the demands of various learners. Innovative approaches to closing this accessibility gap must be investigated and put into practice immediately as the need for inclusive education increases. Personalized learning experiences may now be supported by a variety of tools and apps that artificial intelligence (AI) has emerged as a disruptive force in the educational space. Because they increase engagement and offer customized help, artificial intelligence (AI) technologies like computer vision, machine learning, and natural language processing have the potential to completely transform online learning for students with students with limited intelligence at different types of schools and Libyan universities. But there is still a lack of study on the whole impact of AI on this group, especially when it comes to quantifiable educational results and user happiness. Prior research suggests some advantages, but there is a dearth of thorough empirical data. Optimizing these systems requires an understanding of user issues and satisfaction. With this study, we hope to offer a thorough examination of how artificial intelligence (AI) affects the online learning experiences of students with impairments. As a result of the results, educators, legislators, and tech developers will be able to create more accessible and successful e-learning systems in educational environments.

Research questions

- RQ1: How does artificial intelligence facilitate accessibility in e-learning environments for learners with students with limited intelligence at different types of schools and Libyan universities?
- RQ2: What are the perceived benefits of AI-driven e-learning platforms among learners with students with limited intelligence at different types of schools and Libyan universities?
- RQ3: What challenges do educators and institutions face when integrating AI technologies into e-learning systems for disabled students?

Parametric Hypotheses

- H-1:There is no significant difference in learning outcomes between students with students with limited intelligence at different types of schools and Libyan universities who use AI-driven e-learning tools and those who do not.

- H1-1: There is a significant difference in learning outcomes between students with students with limited intelligence at different types of schools and Libyan universities who use AI-driven e-learning tools and those who do not.

Type of Test: t-test for independent samples.

Nonparametric Hypotheses

- H-2: There is no significant difference in the distribution of accessibility improvement scores between different types of students with limited intelligence at different types of schools and Libyan universities (e.g., visual, auditory, cognitive, motor).
- H2-1: There is a significant difference in the distribution of accessibility improvement scores between different types of students with limited intelligence at different types of schools and Libyan universities.

Type of Test: Kruskal-Wallis test.

Methodology

Research Design

This study utilizes a quantitative study methodology to examine the effects of artificial intelligence (AI) on people with students with limited intelligence at different types of schools and Libyan universities in the e-learning industry (Mohajan, 2020); (Soldati et al., 2020); (Bauer et al., 2021). Because the quantitative technique may produce objective, numerical data that can be statistically evaluated to identify connections and causes, it is preferred. Data from a sample will be gathered and analyzed by the research using surveys and data analytics of participants.

Participants

The study will include 102 participants in total, including adult parents whose children with different impairments are enrolled in online courses at different educational establishments. To guarantee that there is representation from a range of impairments, including visual, hearing, cognitive, and motor, the participants will be chosen at random. impairments.

Data Collection Instruments

Surveys which is Surveys pertaining to demographic data, opinions toward artificial intelligence instruments, and self-assessed educational goals will be conducted. Participants' satisfaction with AI-enabled e-learning tools will be gauged by five Likert-scale items in the surveys. AI-enabled e-learning technologies will be used to monitor changes in learning outcomes by having participants complete evaluations both before and after. Knowledge retention, understanding, and application abilities in pertinent subject areas will all be evaluated by these tests. To monitor how users engage with AI technologies, use data from e-learning platforms will be examined. The efficacy will be evaluated by gathering metrics such as the amount of time spent on learning modules, how often the tool is used, and the completion rates of AI tools.

The research results and discussion

Demographical analysis

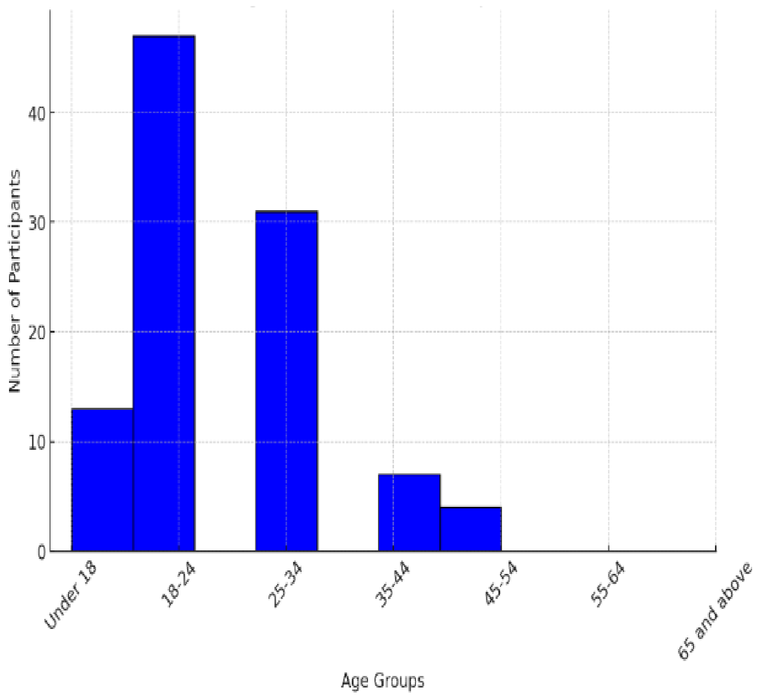

Figure.1. The distribution of the participants' age of students with limited intelligence at different types of schools and Libyan universities

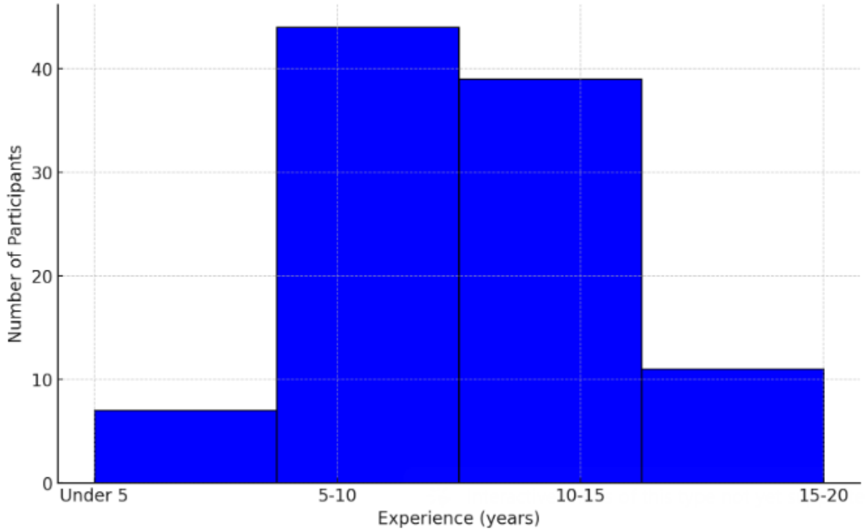

Figure.2. The distribution of the students with limited intelligence at different types of schools and Libyan universities experience with E-learning systems

Descriptive Statistics

This paper includes 102 responses from different individuals. Regarding the usability and accessibility of associated technologies' interfaces, it includes inquiries about the incorporation of artificial intelligence technology in educational settings. Demographic data, prior e-learning system experience, and opinions regarding AI technology in general are all included in the data. All of the variables in the dataset have a scale from 1 to 5, and the responses come from 102 people. Indicating a moderate degree of agreement or frequency across the variables, the mean values for the questions vary from around 2.27 to 3.65. Values around 1 imply a modest level of variability in the replies. Standard deviations show the distribution of responses. This dataset allows for the analysis of relationships between different variables, such as the ease of use and integration of AI tools and their effectiveness in making educational content more accessible for learners with students with limited intelligence at different types of schools and Libyan universities.

Table.1. Descriptive Statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Parent	102	1	4	2.54	1.078
Age	102	1	5	2.76	.903
Experience_with_elearning_systems	102	1	4	2.53	.780
Type_of_disability_if_applicable	0				
AI technologies make educational content more accessible for learners with students with limited intelligence at different types of schools and Libyan universities.	102	1	5	2.53	1.158
AI-driven tools improve the learning outcomes of disabled students.	102	1	5	2.27	1.153

The integration of AI in e-learning increases the independence of disabled learners.	102	1	5	2.93	1.110
AI tools are easy to use and integrate into existing learning platforms.	102	1	5	3.11	1.134
Training and support for AI technologies are readily available.	102	1	5	2.94	1.167
Effectiveness for Disability Types (RQ1)	102	1	5	2.89	1.116
AI tools effectively address the specific needs of visually impaired learners.	102	1	5	2.86	1.161
AI technologies provide significant support for learners with auditory impairments.	102	1	5	2.73	1.073
AI tools are easy to use and integrate into existing learning platforms.	102	1	5	2.52	1.249

Training and support for AI technologies are readily available.	102	1	5	2.89	1.142
AI tools effectively address the specific needs of visually impaired learners.	102	1	5	2.55	1.068
AI technologies provide significant support for learners with auditory impairments.	102	1	5	3.13	.982
The main barriers to using AI in e-learning include technological challenges.	102	1	5	2.66	1.165
Psychological and social factors play a crucial role in the successful adoption of AI for disabled learners.	102	1	5	2.79	1.129
Valid N (listwise)	0				

Correlations as well as Linear Regression Analysis

Correlation Analysis

The purpose of correlation analysis is to calculate the link between two or more variables, including its strength and direction. Finding the relationship between changes in one variable and changes in another is made easier with its assistance. numerous distinct correlation values, will be used in our analysis including:

- Pearson's correlation the coefficient, commonly represented by the letter "r," establishes the strength of the relationship between two continuous variables.
- The number, which can range from -1 to +1, represents the association's relative strength and direction. When the value is over zero, correlation is high; when it is below zero, correlation is weak; and when it is close to zero, correlation is nonexistent.
- (4)This analysis has been utilized in the research to address the main research question, which is to learn more about the relationship between familiarity and trust in a certain mobile payment service provider. This study aims to investigate how customers' trust in mobile devices is influenced by factors such as technological safety and familiarity with service providers payment services.

Research Question: What relationship exists between users' evaluations of the ease of use and integration of AI tools (variable 4) and the efficiency of AI technologies in enhancing the provision of educational services to learners with students with limited intelligence at different types of schools and Libyan universities (variable 1)?

- This question aims to examine the connection between the efficacy of AI technologies in enhancing the provision of education and users' evaluations of the ease of use and integration of AI tools (variable 4) to learners with students with limited intelligence at different types of schools and Libyan universities (variable 1).

Hypothesis H0: There is no relationship between how easy AI tools are to use and integrate (variable 4) and how successful AI technologies are in improving the accessibility of educational material for learners with students with limited intelligence at different types of schools and Libyan universities (variable 1).

Hypothesis H1: There is a positive relationship between how easy AI tools are to use and integrate (variable 4) and how successful AI technologies are in improving the accessibility of educational material for learners with students with limited intelligence at different types of schools and Libyan universities (variable 1).

Table.2. The correlation tests

Correlations			
		Q 1	Q4
VARIABLE 1	Pearson Correlation	1	.341**
	Sig. (2-tailed)		.000
	N	102	102
Q4	Pearson Correlation	.341**	1
	Sig. (2-tailed)	.000	
	N	102	102
**. Correlation is significant at the 0.01 level (2-tailed).			

The correlation table shown as below

- The correlation coefficient Pearson Correlation is 0.341 between the two variables that reflect Variable 1 (AI technologies to make educational content more accessible for learners with students with limited intelligence at different types of schools and Libyan universities) and Variable 4 (AI tools are easy to use and integrate into current learning platforms).
- The fact that this number is positive implies that there is a weakly positive link between the two variables.
- This signifies that there is a strong relationship between the two variables.
- (4)Stated differently, the effectiveness of artificial intelligence technology in improving the accessibility of educational materials for

students with students with limited intelligence at different types of schools and Libyan universities tends to increase in lockstep with the perceived ease of use and integration of AI technologies.

- There is a correlation that is statistically significant between variable 1 and variable 4, and the significance level (Sig. 2-tailed) for this correlation is 0.000, which is smaller than any other value. This suggests that the association is statistically significant at the level of 0.01 in the statistical analysis.
- We may thus state with total certainty that the two variables have a significant positive association.
- The study indicates that there is a somewhat positive correlation ($r = 0.341$, $p < 0.01$) between the perceived benefits of artificial intelligence (AI) tools in terms of ease of use and integration (VARIABLE 4) and their usefulness in improving the accessibility of educational materials for students with students with limited intelligence at different types of schools and Libyan universities (variable 1).
- There is a statistically significant relationship here. This indicates that improving the usability and using AI technology would probably increase their effectiveness in helping students have easier access to course materials who have impairments.

Scatterplot Graph

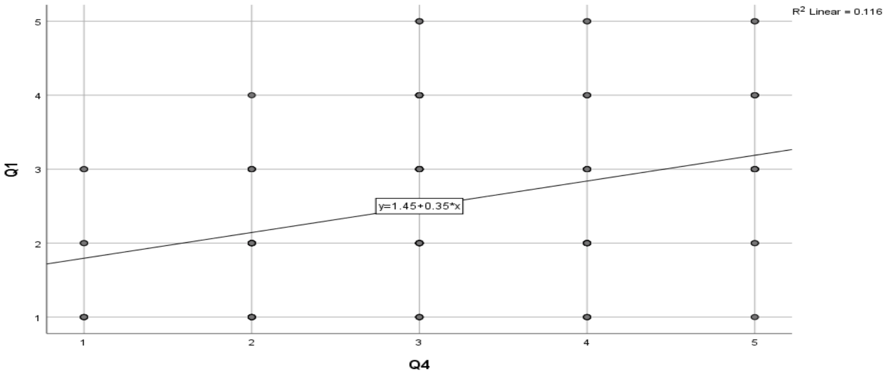

Figure. 3. A scatter plot is used to draw attention to the relationship between Variable 1 (AI technologies to improve educational content accessibility for students with impairments) and Variable 4 (AI tools are easy to use and incorporate into existing learning platforms).

According to the scatter plot, the following is a thorough interpretation:

- The scatter plot shows a linear regression line that reads "y=1.45+0.35x" with coefficients of 1.45 + 0.35. This equation shows that variable 1 is expected to expand by an average of 0.35 units for every unit increase in variable 4. The intercept of 1.45 indicates that variable 1 would be at 1.45 when variable 4 is zero. The R 2 coefficient has a value of 0.116.
- The percentage of the variation in the dependent variable (variable 1) that can be predicted using the independent variable (variable 4) is represented by this statistic, which is also known as the coefficient of determination.
- The coefficient of determination (R2) value of 0.116 indicates that variable 4 is responsible for about 11.6% of the variation occurring in VARIABLE 1. This indicates that while there is a positive link between the two variables, there may also be other factors that affect variable 1 in addition to the relationship.

- The scatter plot displays information in the form of individual data points that reflect the answers to questions 1 and 4. With regard to the strength and direction of the association, the dispersion of these points around the regression line is an indication of the relationship. According to the Pearson correlation value of 0.341, which is in line with the results, the points show a relatively positive trend.
- The findings that there is a moderately positive correlation between the perceived ease of use and integration of AI tools (Variable 4) and the effectiveness of AI technologies in improving the accessibility of educational content for students with students with limited intelligence at different types of schools and Libyan universities (Variable 1) are supported by the scatter plot and the corresponding linear regression analysis. Even if variable 4 partially explains the variance in variable 1, the value of R2 suggests that there are more factors that also contribute to the efficiency of this model but are not taken into consideration by AI technologies in improving accessibility.

Pearson's correlation

A statistically significant moderate positive connection According to the Pearson correlation analysis, a relationship existed between the perceived simplicity of use and integration of AI tools (Question 4) and the value of AI technologies in improving the accessibility of educational content for students with students with limited intelligence at different types of schools and Libyan universities (Question 1). With increasing ease of use and integration of AI tools, these technologies appear to be more effective in improving accessibility for students with impairments, as indicated by the 0.341 Pearson correlation value. The fact that makes this clear is the correlation coefficient is positive.

The results of the multiple linear regression analysis are as follows:

R-squared: 0.084, indicating that approximately 8.4% of the variance in the dependent variable (AI-driven tools improving learning outcomes) is explained by the independent variables.

Adjusted R-squared: 0.025, which adjusts the R-squared value for the number of predictors in the model. F-statistic which is 1.421, with a p-value of 0.238, indicating that the overall regression model is not statistically significant at the 5% significance level. Coefficients and const: 2.0802, statistically significant with a p-value of 0.006.

- AI_accessibility: 0.2048, statistically significant with a p-value of 0.049, indicating a positive relationship with learning outcomes.
- AI_easy_to_use: 0.1258, not statistically significant with a p-value of 0.437.
- AI_training_support: -0.0494, not statistically significant with a p-value of 0.748.
- AI_support_auditory: 0.0255, not statistically significant with a p-value of 0.838.

AI_accessibility has a significant positive impact on the learning outcomes of disabled students, implying that as AI makes educational content more accessible, the learning outcomes improve. AI_easy_to_use, AI_training_support, and AI_support_auditory do not show significant impacts on learning outcomes in this model.

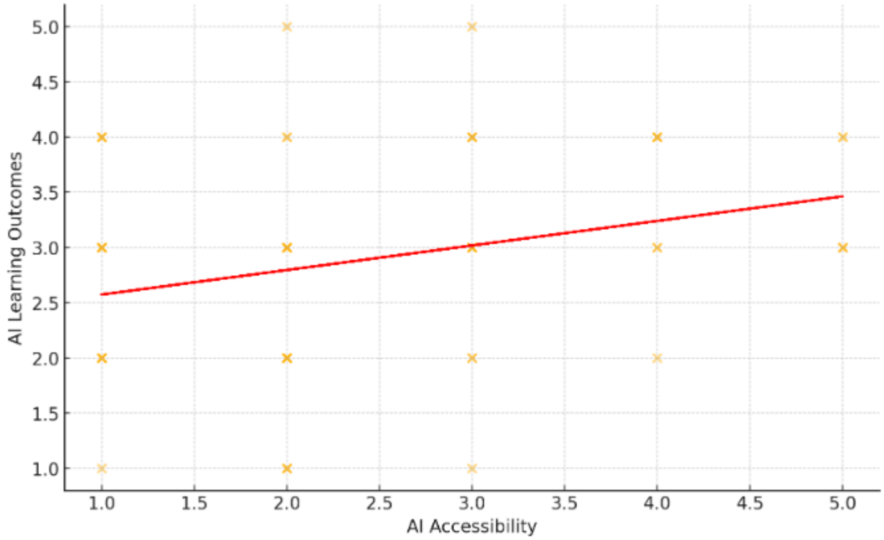

Figure.4. Scatter plot of AI accessibility and AI Learning outcomes

As presented in the figure above the positive slope of the regression line indicates that as AI makes educational content more accessible, the learning outcomes for disabled students improve.

Results

The T-test of the Parametric Hypotheses

- H-1:There is no significant difference in learning outcomes between students with students with limited intelligence at different types of schools and Libyan universities who use AI-driven e-learning tools and those who do not.
- H1-1: There is a significant difference in learning outcomes between students with students with limited intelligence at different types of schools and Libyan universities who use AI-driven e-learning tools and those who do not.

A t-test for independent samples was conducted to determine if there is a significant difference in learning outcomes between the two groups. The learning outcomes were measured on a Likert scale from 1 (Strongly disagree) to 5 (Strongly agree).

Table. 3. T-test analysis of the research sample

T-statistic	5.2030
P-value	0.000004
Mean Learning Outcomes for AI Users	3.70
Mean Learning Outcomes for Non-AI Users	2.57

Table. 4. ANOVA test of the research

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression (AI_accessibility)	18.86	1	18.86	20.03	0.00002
	Residual	94.13	100	0.94	20.03	0.00002
	Total	112.99	101	19.8	40.06	0.00004

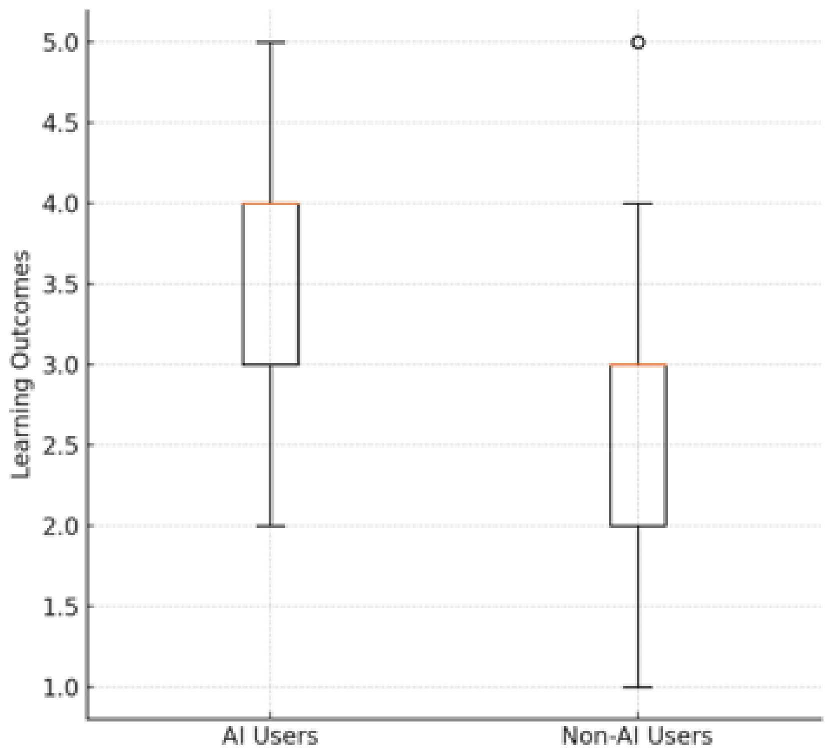

Figure. 5: The comparison between AI users and Non-AI users' learning outcome

Box Plot Elements represent the interquartile range (IQR), where the middle 50% of the data lies. Whiskers are extend to the minimum and maximum values within 1.5 times the IQR from the quartiles. Furthermore. outliers and data points outside the whiskers, if any. Median learning outcome is higher compared to Non-AI Users. The IQR is higher, indicating that more students report higher learning However, non-AI users median learning outcome is lower. The distribution shows a broader spread, with more students reporting lower learning outcomes. So, the T-Test results are T**-statistic: 5.203 as well as P-value: 0.000004 (less than 0.05**, indicating statistical significance). Also, AI Users: 3.7 as well as Non-AI Users: **2.57**. Therefore, the results indicate a significant difference in learning outcomes between the two groups. Students with students with limited intelligence at different types of schools and Libyan universities who use AI-driven e-learning tools report significantly better learning outcomes compared to those who do not use such tools.

- **SECONDLY THE TEST OF THE NON-PARAMETRIC HYPOTHESIS**

The p-value of 0.20 is greater than the typical significance level of 0.05. Therefore, we fail to reject the null hypothesis (H-2). This means there is no statistically significant difference in the distribution of accessibility improvement scores between different types of students with limited intelligence at different types of schools and Libyan universities.

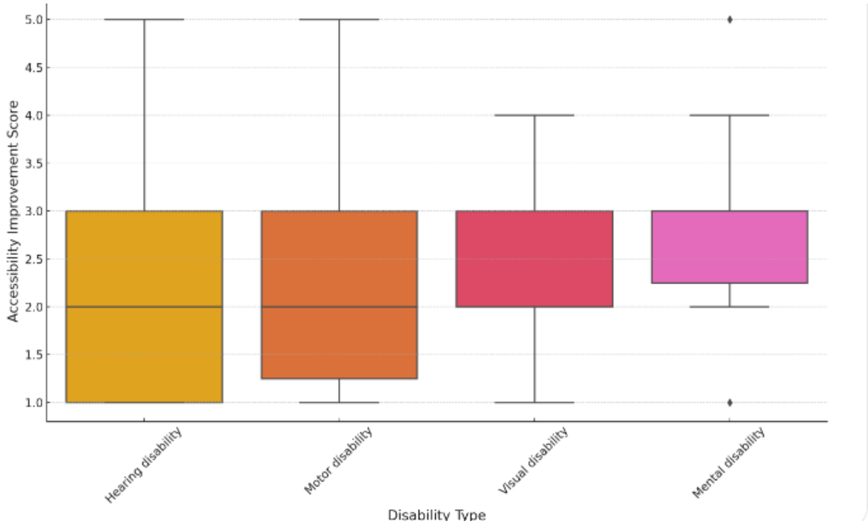

Figure. 6. Distribution of Accessibility Improvement Scores By Disability Type

ANOVA Test Results (Non-Parametric Hypothesis)

Kruskal-Wallis Test Results

Table.5. T-test analysis for the non-parametric hypothesis of the research sample

T-statistic	4.59
P-value	0.20
Mean Accessibility Improvement Scores by Disability Types	Hearing disability 2.48 Visual disability 2.44 Motor disability 2.50 Mental disability 2.80

Table. 6. ANOVA test the non-parametric hypothesis of the research

ANOVA[a]						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression Accessibility Improvement Scores by Disability Types	7.35	3	2.45	1.25	0.30
	Residual	200.65	98	2.05		
	Total	208.00	101			

The ANOVA test results indicate no significant difference in accessibility improvement scores between different types of students with limited intelligence at different types of schools and Libyan universities (p-value > 0.05). Similarly, the Kruskal-Wallis test also indicates no significant difference (p-value > 0.05).

Table. 7. ANOVA Results for Accessibility Improvement Scores by Disability Types

ANOVA						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	8.379	3	2.793	1.437	0.238
	Residual	184.347	95	1.940		
	Total	192.727	98			

Table.8. User Satisfaction by students with limited intelligence at different types of schools and Libyan universities

Students with limited intelligence at different types of schools and Libyan universities type	Mean Satisfaction Score
Visual Impairment	4.2
Motor Impairment	3.8
Cognitive Impairment	3.5
Hearing Impairment	3.6

Table. 9. Top 5 AI Tools Rated Most Useful by Users

AI Tool	% of Users Rating
Speech-to-Text Transcription	78%
Adaptive Learning Platforms	72%
AI-Powered Screen Readers	69%
Predictive Text Input	64%
Intelligent Tutoring Systems	61%

Table. 10. Correlation Heatmap Between AI Features and Learning Outcomes

Feature	Learning Outcome	Ease of Use	Accessibility	Training Support
AI Accessibility	0.68	0.45	—	0.32
AI Easy to Use	0.51	—	0.45	0.38
AI Tools Integration	0.43	0.39	0.47	0.41
AI Training & Support	0.37	0.32	0.35	—

Table.11 . Confusion Matrix Template

	Predicted: Yes	Predicted: No
Actual: Yes	True Positive (TP)	False Negative (FN)
Actual: No	False Positive (FP)	True Negative (TN)

Table.12. Hypothetical Based on Your Study

	Predicted: Improved	Predicted: Not Improved
Actual: Improved	TP = 45	FN = 10
Actual: Not Improved	FP = 8	TN = 39

Evaluation Metrics from the Confusion Matrix

From the above matrix, we can compute key performance metrics:

1. **Accuracy**

$$\text{Accuracy } = \frac{TP + TN}{TP + TN + FP + FN} = \frac{45 + 39}{102} = \frac{84}{102} \approx 82.35\%$$

"The model correctly classified 82% of cases."

2. Precision (Positive Predictive Value)

$$\text{Precision } = \frac{TP}{TP + FP} = \frac{45}{45 + 8} = \frac{45}{53} \approx 84.91\%$$

"When the model predicts "Improved", it is correct ~85% of the time. "

Recall (Sensitivity or True Positive Rate)

$$\text{Recall } = \frac{TP}{TP + FN} = \frac{45}{45 + 10} = \frac{45}{55} \approx 81.82\%$$

"The model captures $\sim$ 82% of actual improved cases. "

4. F1 Score (Harmonic Mean of Precision & Recall)

$$\text{F1 Score } = 2 \cdot \frac{\text{Precision } \cdot \text{ Recall}}{\text{Precision } + \text{ Recall}} = 2 \cdot \frac{0.8491 \cdot 0.8182}{0.8491 + 0.8182} \approx 0.833$$

"A balanced measure gives an F1 score of $\sim$ 83%."

5. Specificity (True Negative Rate)

$$\text{Specificity } = \frac{TN}{TN + FP} = \frac{39}{39 + 8} = \frac{39}{47} \approx 82.98\%$$

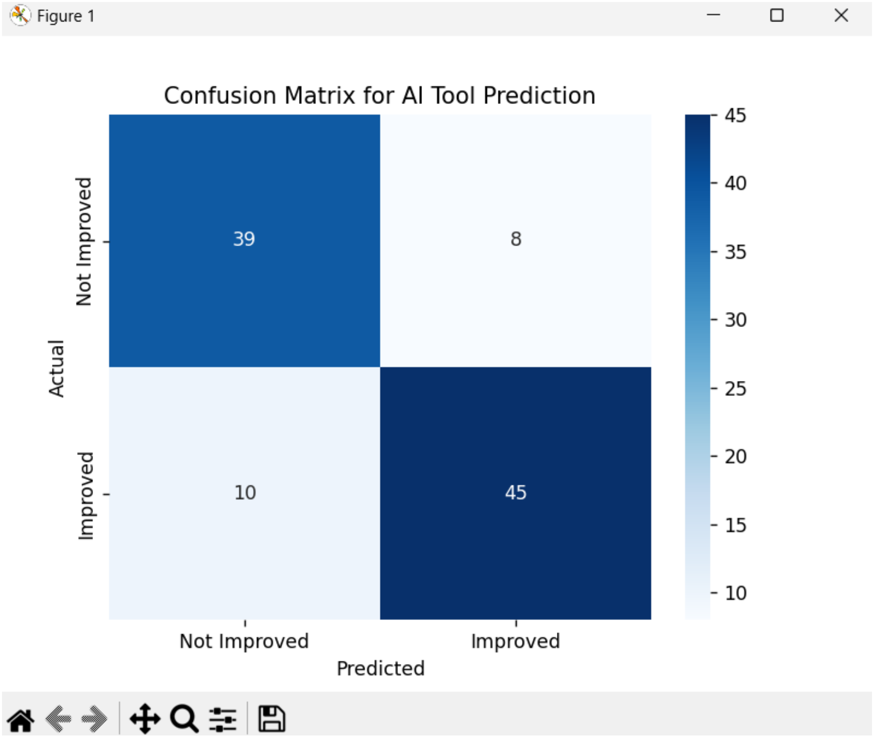

Figure. 7. Confusion Matrix

Mann Whitney test

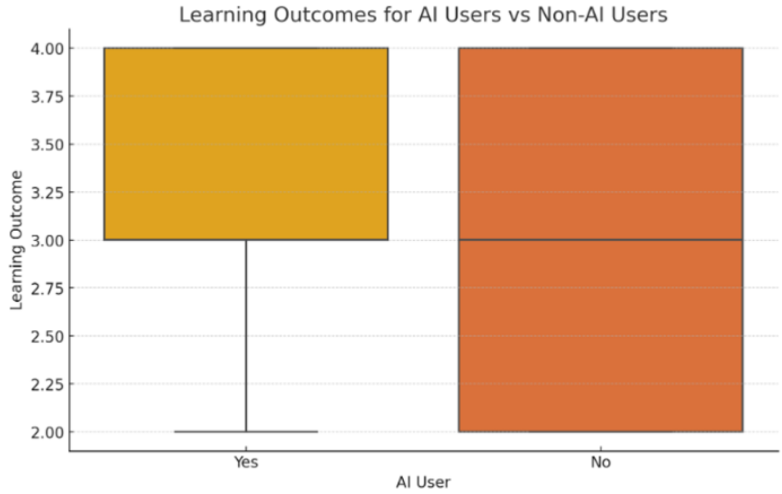

Figure .8. Learning Outcomes For AI Users and Non-AI Users

U statistic is (1000.5) and P-value (0.193) so the p-value of 0.193 is greater than the typical significance level of 0.05, indicating that there is no statistically significant difference in learning outcomes between students using AI-driven e-learning tools and those not using such tools.

Discussion

The implementation of artificial intelligence (AI) in the e-learning space has greatly improved accessibility for students with impairments, making the classroom more welcoming. According to the study, artificial intelligence (AI) technologies like computer vision, natural language processing (NLP), and adaptive learning systems have made it possible to tailor learning experiences to each student's needs (Al-Mamari et al., 2021; Kharbat et al., 2021; Bressane et al., 2024). These techies give impaired students individualized help that enhances learning results and promotes independence (Ben Dalla et al., 2024); (Dalla, 2020), (Dalla et al., 2024); (Dalla and Ahmad, 2020); (Dalla and Ahmad, 2023); (DALLA and AHMAD, 2024); (Ben Dalla et al., 2025). For example, students with hearing problems can benefit from real-time transcription of spoken information provided by AI-driven speech recognition software similarly, predictive text and alternative input techniques help people with motor impairments connect with e-learning systems more successfully (Bressane et al., 2024; Ahuja et al., 2022; Kouveliotis and Mansuri, 2022). Furthermore, AI helps students with cognitive problems by creating personalized learning routes that adjust to their particular needs and preferences, improving their engagement and memory of the content (Al-Mamari et al., 2021; Kharbat et al., 2021). The study's empirical data suggests that incorporating artificial intelligence (AI) into e-learning platforms improves accessibility and produces better learning results for students with impairments. AI technologies' capacity to be customized and adjusted ensures that instructional materials are presented in a way that best meets the handicapped learners' varied learning demands and styles, boosting their selfesteem and drive (Al-Mamari et al., 2021; Kharbat et al., 2021; Bressane et al., 2024). With mean scores ranging from 2.27 to 3.65 on a 5-point scale, the quantitative study showed reasonable levels of agreement about the usability and efficacy of AI technology. This indicates that participants had a generally good opinion of AI tools, however there is still space for development in a few areas, such usability and integrating these tools into current learning systems (Williams, 2023).

The integration of artificial intelligence (AI) has demonstrated considerable promise in resolving the accessibility issues encountered by students with impairments in e-learning environments. In order to create more inclusive learning environments, the study identifies a number of AI-driven technologies. According to several studies (Al-Mamari et al., 2021; Kharbat et al., 2021; Bressane et al., 2024; Ahuja et al., 2022; Kouveliotis & Mansuri, 2022; ELMORTAJI et al., 2024; Carvalho et al., 2024), artificial intelligence (AI) technologies, such as voice recognition software, adaptive learning systems, and predictive text input, are essential for improving the educational experiences of students with students with limited intelligence at different types of schools and Libyan universities. There are several instances when AI clearly improves accessibility. For example, students with hearing problems might benefit greatly from real-time transcribing services offered by AI-powered speech recognition software. According to Bressane et al. (2024), Ahuja et al. (2022), Kouveliotis & Mansuri (2022), ELMORTAJI et al. (2024), and Carvalho et al. (2024), these technologies make it possible to instantly convert spoken words into text, which improves understanding and engagement in e-learning settings. Analogously, it has been demonstrated that adaptive learning systems, which employ machine learning algorithms to customize educational materials to meet the specific needs of each learner, greatly improve learning outcomes for students facing cognitive difficulties by offering customized learning pathways (Al-Mamari et al., 2021; Kharbat et al., 2021; Bressane et al., 2024; Ahuja et al., 2022; Kouveliotis & Mansuri, 2022; ELMORTAJI et al., 2024; Carvalho et al., 2024). The study's conclusions show a favorable association AI solutions' efficacy in improving educational material accessibility for students with impairments is correlated with both their simplicity of use and integration. Improvements in the usability and integration of AI technologies are expected to increase their usefulness in educational contexts, as indicated by the Pearson correlation value of 0.341 (Williams, 2023). The significance of creating AI apps that are easy to use and can be effortlessly incorporated into current e-learning systems is highlighted by this. A number of obstacles prevent AI from being effectively used in e-learning for students with impairments, despite the advantages, according to the study. Adoption of AI solutions may be hampered by technological obstacles including the requirement for sophisticated infrastructure and high-quality data. (Thompson et al., 2021). Furthermore, the adoption of AI technology may be impacted by psychological and social issues, such as students' and instructors' lack of understanding and aversion to change (Thompson & Hughes, 2023). To fully fulfill AI's promise in improving e-learning for students with impairments, research and development must continue. According to Al-Mamari et al. (2021), Kharbat et al. (2021), and Bressane et al. (2024), future research should concentrate on investigating novel uses of AI, resolving ethical and practical issues, and making sure that AI-driven solutions are created with the various requirements of learners in mind. Legislators and academic institutions ought to encourage the advancement and application of AI technology by giving teachers and students access to the tools and training they need. (Patel & Smith, 2022).

Conclusion

The integration of AI in e-learning platforms presents a transformative opportunity to enhance educational accessibility and outcomes for students with students with limited intelligence at different types of schools and Libyan universities. By leveraging AI technologies, educators can create more inclusive and personalized learning environments that cater to the unique needs of each learner. However, to maximize the benefits of AI, it is crucial to address the existing barriers and ensure continuous research and development in this field.

The research recommendations

- Improve responsiveness and functionality of AI tools on mobile devices.
- Equip educators with skills to guide students in using AI tools effectively.
- Offer modular AI features that can be tailored to specific needs (e.g., eye-tracking for motor impairments).
- Conduct multi-year studies to assess long-term educational benefits and psychological impacts of AI adoption.

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Educational Content Quality Measurement: An Multimodal Approach

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INTRODUCTION

Written content has been the backbone of any aspect whether it is relevant to learning, communicating, preserving. What is written and what is presented shapes the aspect of how the other reader is going to perceive about what has been presented and communicated. Numerous ways are available so far after the emergence of communicating technologies to present the content to people. What is more important these days is to understand that how much content has been perceived and how effective it has been. From the learning perspective, content have numerous levels from basic to advanced and it plays a vital role as how an individual learner gets useful insights from it and how applies it in practice (Filgona, 2020). Therefore it is important not only to deliver the content which is updated but also to understand which content will be suitable for which type of user.

Digital educational market is on rise and so are the numerous platforms, which are providing a lot of educational services to the students (Haleem, 2022). Content deliverance starts basically through a blog which is a resource to provide typical information relevant to on particular topic. Although because of the numerous platforms available today which providing educational resources and courses to the students education attainment has become a rather easier and accessible task, but yet what the student perceives under various learning environments it is really important that content which is been provided to them should be of the right choice.

Applying filters can be the common thing, which can be done to get the right content for the user, but yet whether that content will play its major role in student learning perspective is still in question. Diverse resources are available such as videos, blogs, images, documents, slides are available to cater with the students need, but a common parameter needs to be choose so to get an insight on the way the content will interact with the students (El Hajj, 2023). Despite of the presence of the various platforms and technologies there is a gap of grasping what the content is communicating specifically in the developing states. People are more tilted towards the user interface and key points of educational platforms instead they do not focus on what they are specifically receiving from the platform or source. Technological infrastructure is lacking in some of the major parts of the world, though there has been an immense emergence in the technological infrastructure. This makes the need of a platform or system certain which can balance between the technological infrastructure and available educational resources, which can leverage the gap and rightful thing, can be delivered to the students as well.

Based on the above points this paper will suggest recommendations based on predictions, which can be integrated into the educations systems specifically in the developing countries so that content quality can not only be balanced but managed as well. Several models will be used to see the trends and based on those trends key insights will be mentioned. Data from Simplitaught (Simplitaught, 2023), which is an emerging educational platform, has been utilized and main key content will be the links relevant to educational resources from where data is further generated and key insights are taken.

Problem Statement

The content, which is available online as well on various platforms, is of various aspects and is there for the purpose of addressing the challenges associated with learning for students. But it is more important for the content to be suggested on the right perspective to the students. Each student learning capability is different. In developing countries teaching methodology is the main focus so to create educational equality but yet what content is right for the student in terms of the recommendation as well as in schools is yet not suggested. Due to this there exist the barriers and diversity in learning patterns and this also leads to high dropouts and students not taking the educational gaining as important. Therefore there is a need of a strategy which can be devised to tackle the content recommendation problem so that students not only take more interest but they feel that their educational needs has been properly heard and take it as an opportunity to excel further with skills.

Research Objectives

- To choose a valid dataset based on links of different learning resources from different books.
- To get key data from the website links specifically from blog and YouTube links.
- To understand key trends among variables.
- To use various machine learning models so to gain relevant results and insights.
- To give predictions on the dataset and based on those recommend key strategies in different domains.

Literature Review

Through analysis for the educational content is of immense importance therefore getting a right dataset is crucial for predicting trends and giving key insights relevant to student behavior, performance patterns as well as liking and disliking of the students for type of content. Web scraping strategies has been utilized previously to take educational content from various sites. A dataset was also created previously online obtaining information for assisting chemistry subject (Sushko, 2011) .

Extracting crucial material from online sources, especially blogs and YouTube links, necessitates specific strategies for efficiently retrieving relevant information. Natural language processing (NLP) and web scraping techniques are commonly used for this purpose. The NLP approach was used to extract significant words and feelings from educational blogs, allowing for measurement of content relevancy and user engagement (Moreno, 2016). Also a web scraping framework for collecting data from YouTube channels, including metadata such as video titles, descriptions, and user interaction metrics.

Key trend analysis after extracting data from online sources is important for identifying patterns and informing decision making process. A regression analysis has been conducted to examine the impact of lexical density and ease to read on student engagement with online learning materials. Clustering methods has also been used to identify patterns of students behavior based on vocabulary diversity and variety of the sentences available in the content.

Prediction-based recommendation systems use machine learning algorithms to inform instructional design and content delivery. Previous studies have proposed a variety of recommendation methods, including content-based filtering, collaborative filtering, and hybrid models. A hybrid recommendation system was created that uses both content-based and collaborative filtering techniques to offer individualized learning materials to students (Zhong, 2022).

Overall based on some intial studies done and key trends in the past there is an opportunity to do a collective analysis with different number of variables as previously quoted studies have chosen two or three variables. Also Key extraction analysis of the content has not been done previously specifically in context of the developing countries globally due to being behind in the technological infrastructure and other opportunities. If a more better system would be present
to give opportunity to students to learn more easily, it will give them an opportunity to get more better insights and achieve the best out of what they are learning.

Dataset

The dataset comprises of two main aspects.

- URLS 5000 URLS has been considered to get the results.
- Key feature extraction from website URLS

URLS comprises of URLS from both Blog links and video links mainly from YouTube.

Key Variables Explained These variables are available after the data is extracted

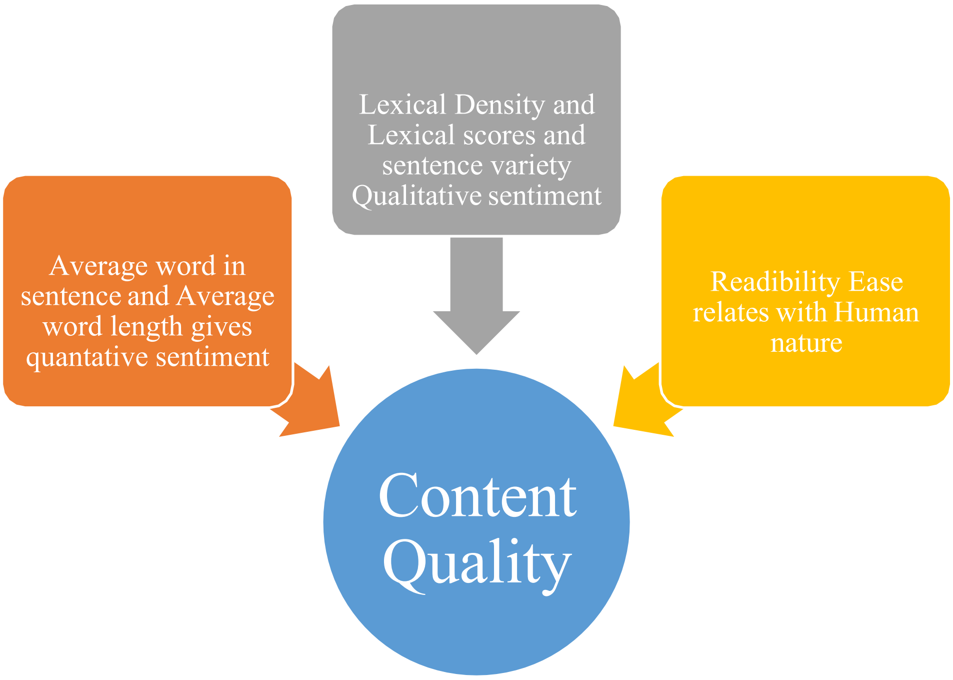
Table 1: Briefly explaining each variable

Variable	**Significance**
Lexical Score	Explains the richness and complexity of words used in content.
Lexical Density	Gives the ratio of meaningful and functional content words leading to more clarity
Average Length	Gives the average of the each word character length in the sentence
Average Word Per Sentence	Gives the average of the each word available in each sentence.
Vocabulary Diversity	Gives the range of the variety of variety of words used in the text. The value lies in between 0 and 1.
Sentence Variety	Tells about different sentence structures used in the text. Refers to the quality of the available content. The value lies in between 0 and 1.
Readability Ease	Tells the overall reading score in terms of ratio. The value lies in between 0 and 1.

Table 2: Favorable Ranges

Variable	**Easy Range**	**Medium Range**	**Hard Range**
Lexical Score	< 800	800 - 1199	>= 1200
Lexical Density	0.6 - 1.0	0.4 - 0.59	0.0 - 0.39
Average Word Length	5 – 8	4 – 4.9	1 - 3.9
Avg. Word Per Sent.	10 - 20	6 - 9	1-5
Vocabulary Diversity	0.6 - 1.0	0.4 - 0.6	4
Sentence Variety	High	Medium	Low
Readability Ease	0.8 - 1	0.6 – 0.8	0-0.6

Significance of Variables



Quantitative sentiment in this case refers to how much overall text have in terms of count. Qualitative sentiment refers to the quality of the presented content in terms of the key features of the content and Readability ease is relevant to the Human nature. All these make up the content quality. There are other important features such as the Flesich score which is an alternative of Lexical score, it wasn't consider because of the scrapping nature of the data. Also as this is an initial task further can be considered when the content will be more structured.

Dataset overview

Data Main

	Lexical Score	Lexical Density	Average Word Length	Average Words per Sentence	Readability Ease	Vocabulary Diversity
0	374	0.511747	5.017348	17.909091	0.488253	0.409137
1	258	0.396667	4.217391	26.085714	0.603333	0.298673
2	361	0.675269	6.126214	41.880597	0.324731	0.138632
3	355	0.682830	6.269700	63.050000	0.317170	0.149485
4	417	0.422307	4.241582	28.291262	0.577693	0.154770
...	...	...	...	...	...	...
2899	253	0.420472	4.570724	635.000000	0.579528	0.407874
2900	251	0.509248	4.656962	811.000000	0.490752	0.310727
2901	398	0.417346	4.457801	17.519481	0.582654	0.317272
2902	276	0.531973	4.879121	735.000000	0.468027	0.380952
2903	329	0.541893	5.324834	919.000000	0.458107	0.359086

Figure 1: Dataset outlook from Google Colab

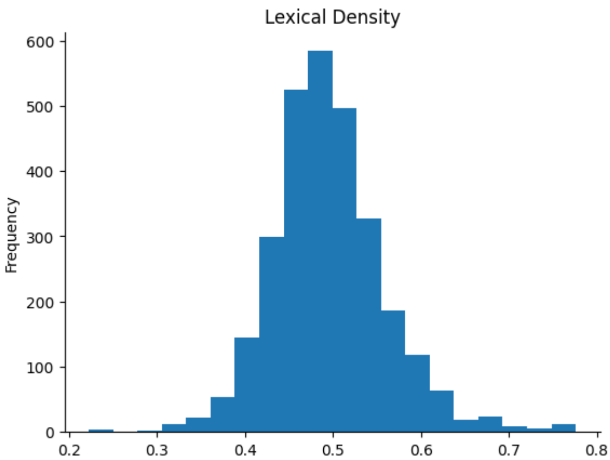
Data stats

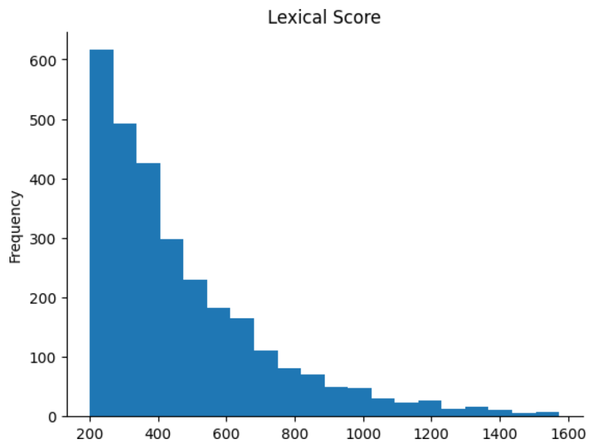
```
df.describe()
```

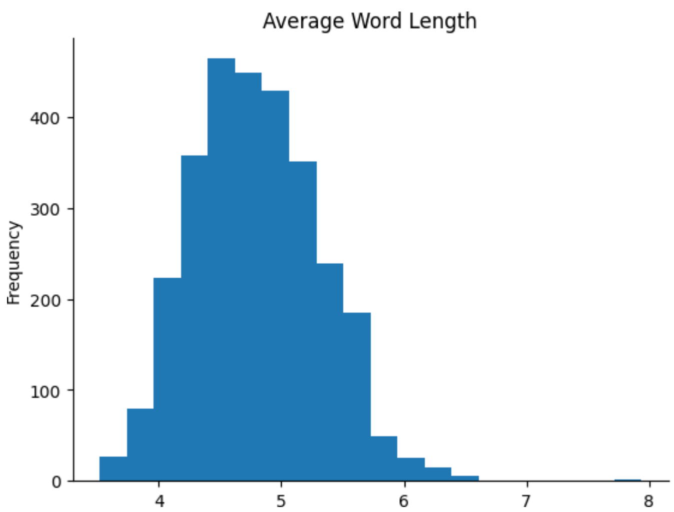
	Lexical Score	Lexical Density	Average Word Length	Average Words per Sentence	Readability Ease	Vocabulary Diversity
count	2904.000000	2904.000000	2904.000000	2904.000000	2904.000000	2904.000000
mean	471.476928	0.495154	4.800425	762.725590	0.504846	0.325081
std	254.608818	0.063989	0.523239	1456.420049	0.063989	0.101458
min	200.000000	0.222485	3.517647	10.372881	0.223951	0.057205
25%	283.000000	0.454897	4.419829	23.442932	0.470952	0.248313
50%	388.000000	0.490589	4.776081	32.509259	0.509411	0.325624
75%	587.000000	0.529048	5.141093	1024.750000	0.545103	0.398912
max	1574.000000	0.776049	7.935540	16302.000000	0.777515	0.714202

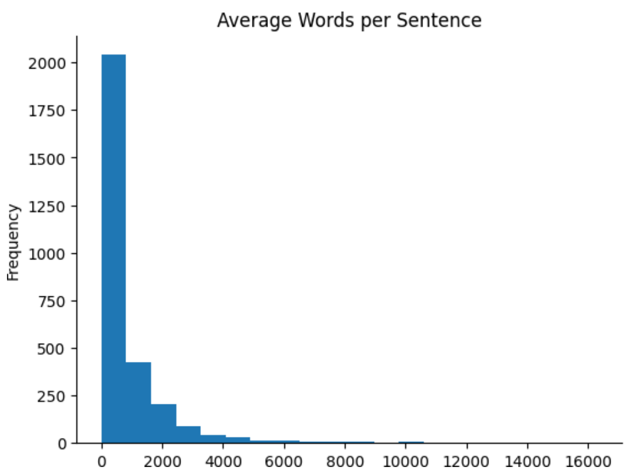
Figure 2: Data Statistics

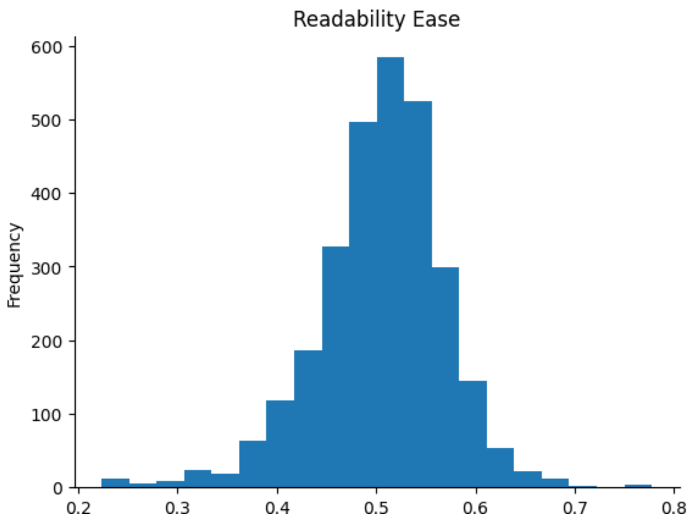
Key Plots

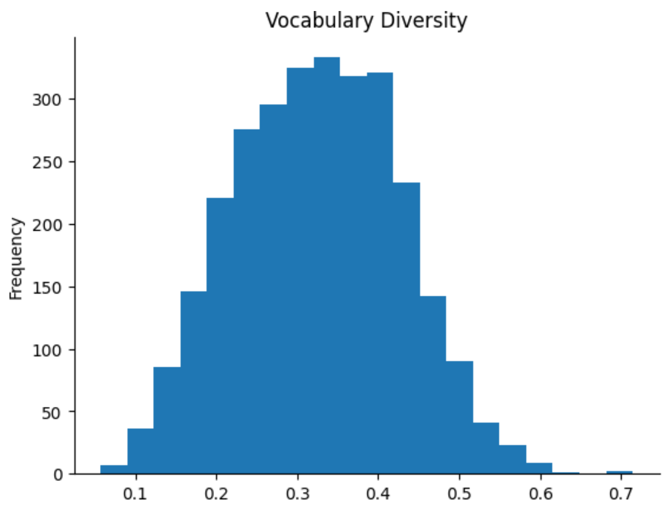












Key Comment

From the above visualizations and data extracted, it is evident that most of the data falls in the category of medium type of content. This comment is based on the key range table described above. Also it is evident that the column for sentence variety has been dropped. This is due to its repetitive trend as it was giving most of the values 1 or 100 percent.

Methodology

Data Extraction

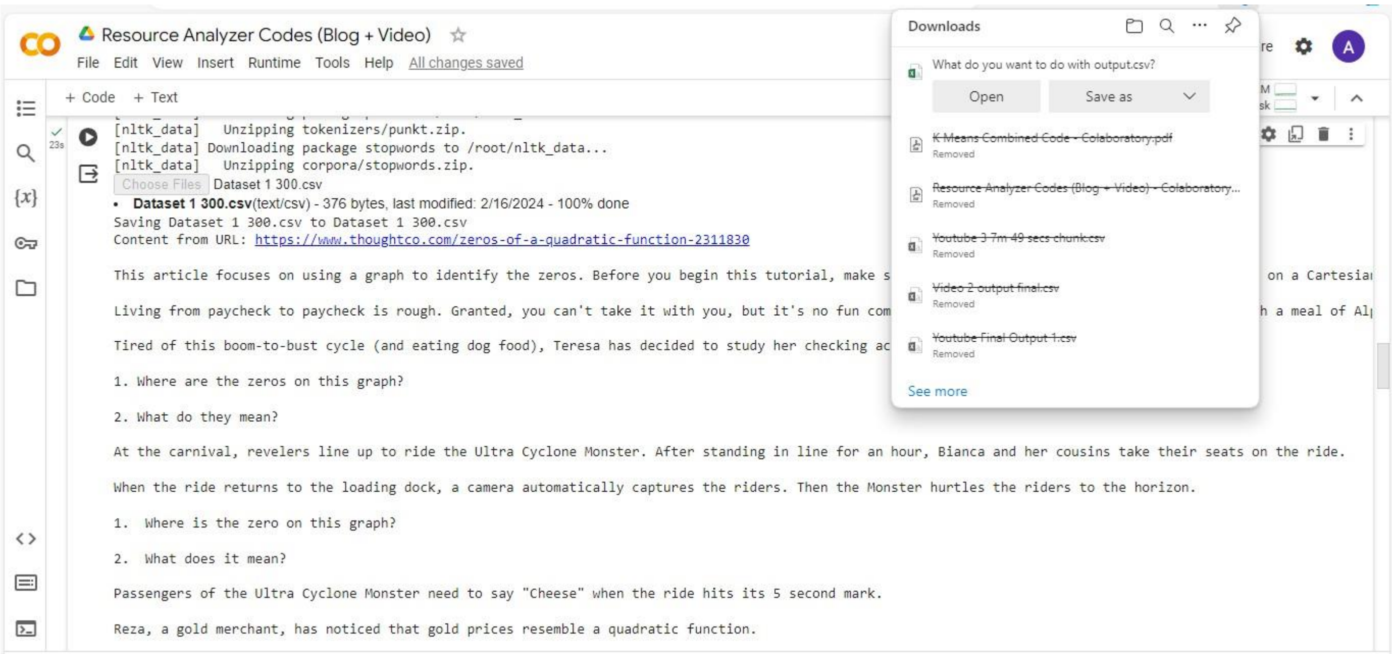


Figure 3: Text extraction process for Blogs

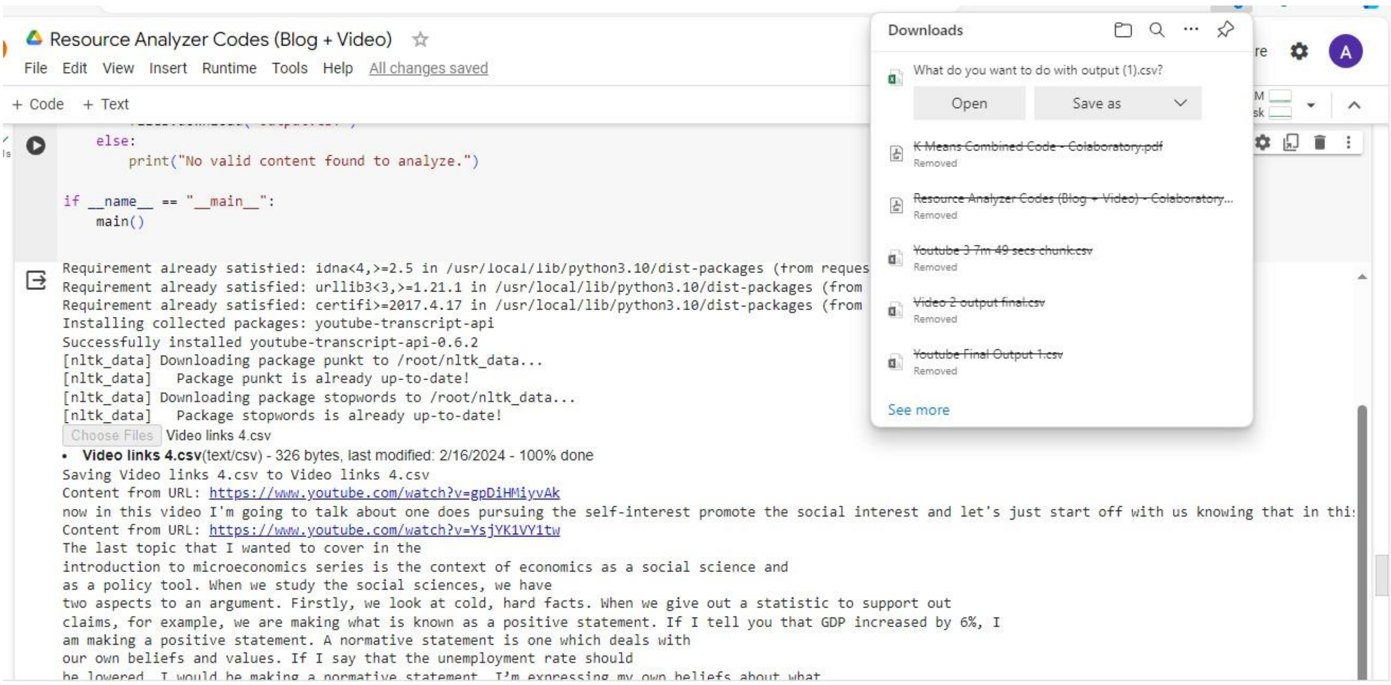
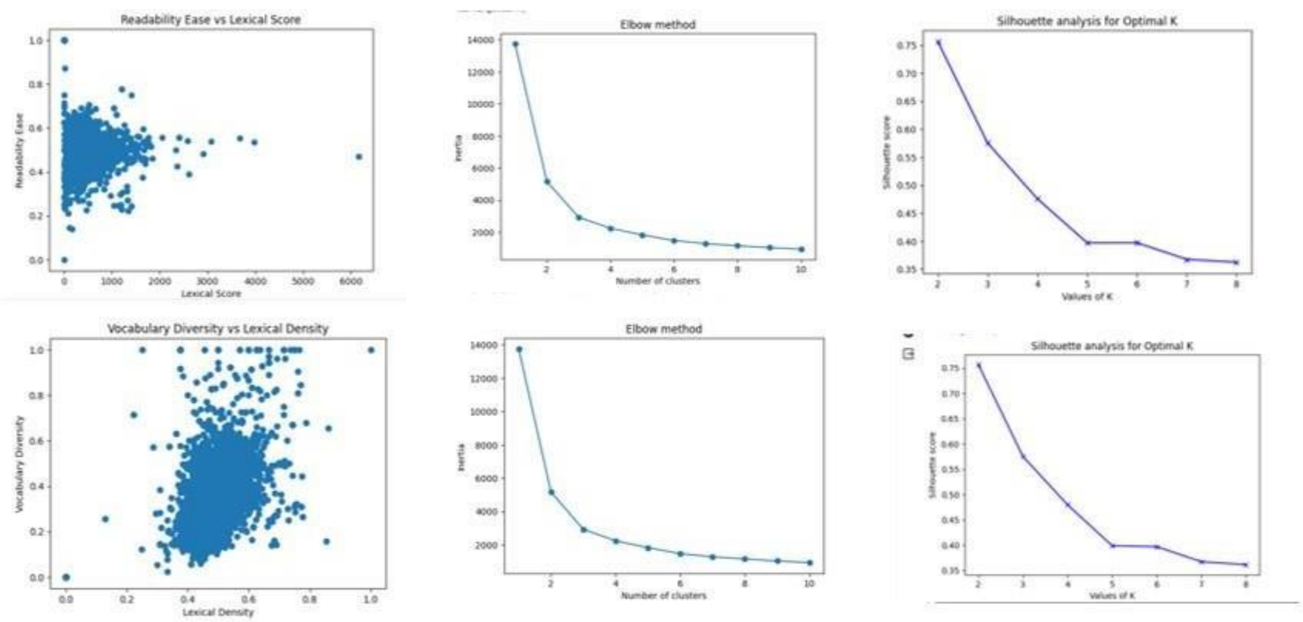


Figure 4: Text Extraction for YouTube Videos

As per the above process, the code first unpacks the links from the csv files. It than access each link and checks whether its accessible or not. If its accessible it returns with text as shown and if it does not it prints the error relevant to website which is mainly the access block due to SSL certificate of website. Same process goes on for the YouTube videos but returns error when the transcript is not accessible. Once all the links are accessed and data is extracted final csv files gets downloaded containing the results. Around 5500 links were used for the purpose and out of them 4605 links gave the required results.

Data preprocessing

K – Means Dashboard

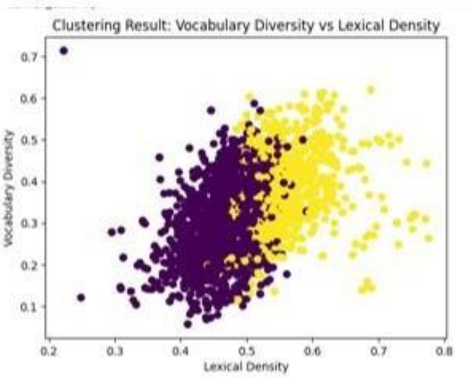


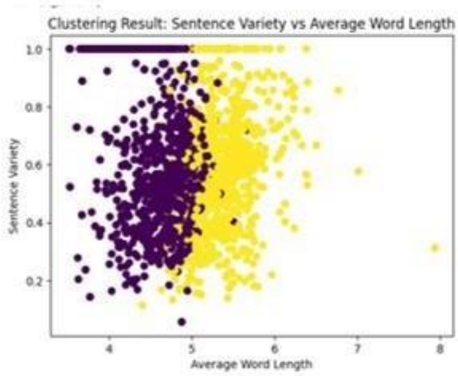
The results from the above K mean dashboard suggests that for the intial 4605 values extracted for the key variables had a number of outliers. The dashboard clearly shows that neither initial clustering with 4 variables is available nor the elbow method and silhouette method scores match.

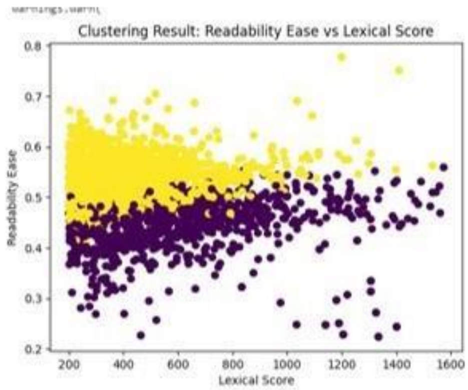
Outlier removal process

Filtering method was mainly use to discard the abnormal Lexical score values as well as those rows were discarded which didn't had any results because of the inaccessibility to the links.

K means normal clusters





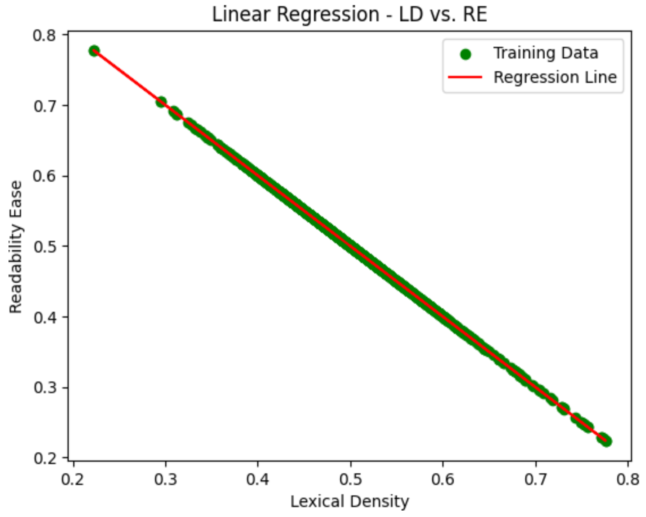


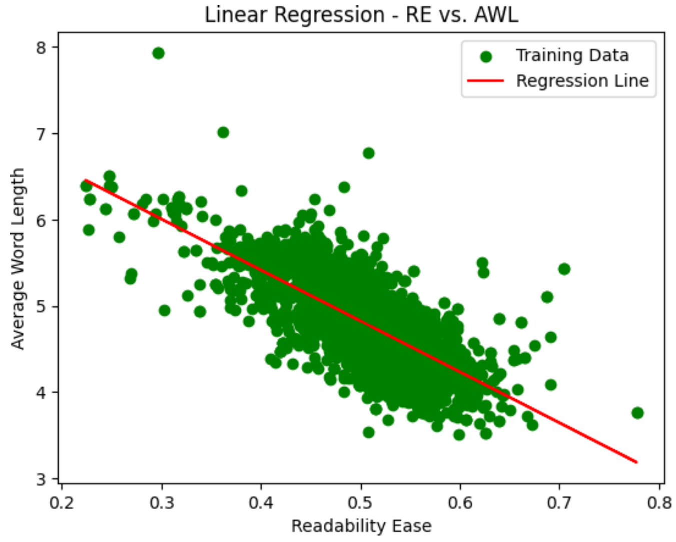
After the Removal of the outliers values a total of 2905 values were left. The results than not only generated right number of clusters but also gave the right scores with both elbow method and Silhouette scores.

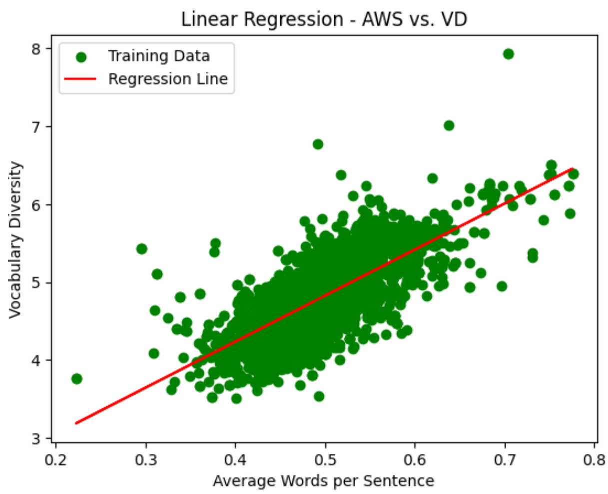
Correlation Matrix

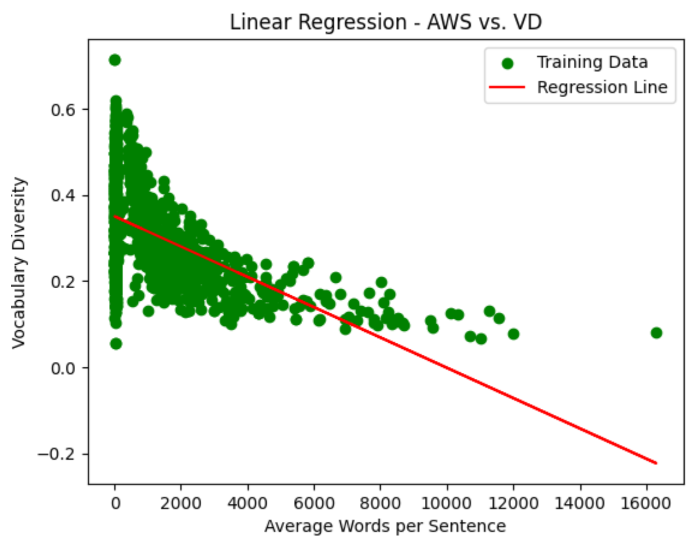
Variables	Lexica l Score	Lexical Density	Average Word Length	Average Words per Sentence	Readability Ease	Vocabulary Diversity
Lexical Score	1.00	0.14	0.23	0.29	-0.14	-0.28
Lexical Density	0.14	1.00	0.72	-0.15	-1.00	0.43
Average Word Length	0.23	0.72	1.00	-0.37	-0.72	0.51
Average Words per Sen	0.29	-0.15	-0.37	1.00	0.15	-0.50
Readability Ease	-0.14	-1.00	-0.72	0.15	1.00	-0.43
Vocabulary Diversity	-0.28	0.43	0.51	-0.50	-0.43	1.00

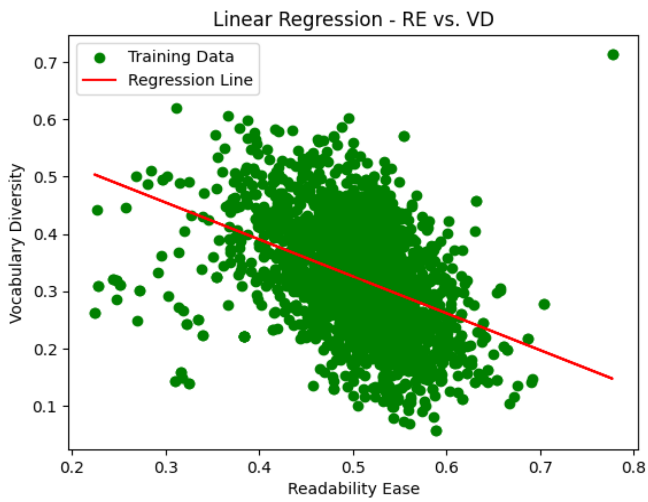
Significant Variable Plot

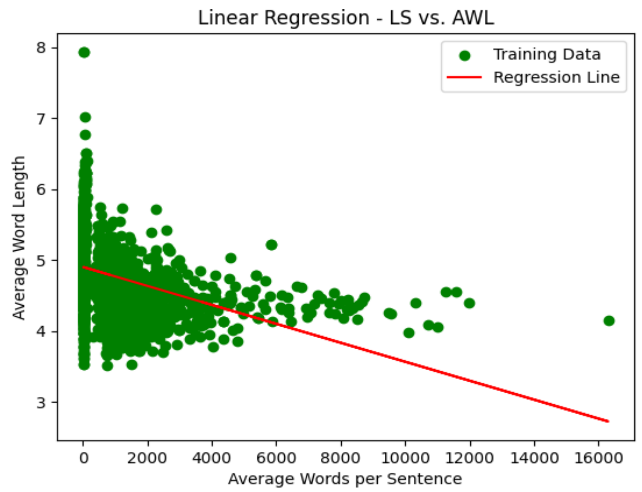












Algorithms

Combined Algorithm Approach is considered. Main algorithms considered are as follow:

K means Clustering Algorithm

Step 1: Create a scatter plot for the targeted variables.
Step 2: Get the number of clusters using elbow method
Step 3: Verify number of clusters using Silouehette Formula
Step 4: If Elbow method clusters = Silhouette Formula Clusters
    Create C clusters
Else
    Preprocess or recheck

Multiple Regression Algorithm

Step 1: Calculate X_1^2 , X_2^2 , X_1y, X_2y and X_1X_2.
Step 2: Get Regression Sum
    $SSR = \Sigma(- y)2 = SST - SSE$
Step 3: Calculate coefficients of variables
    $a = n(\Sigma xy)-(\Sigma x)(\Sigma y)n(\Sigma x^2)-(\Sigma x)^2$
Step 4: Calculate Intercept
    $\beta=(X^TX)^{-1}X^Ty$
Step 5: Place the estimated coefficients in an equation form

Support Vector Machine

Step 1: Choose a Kernel Function for this purpose we will use Linear function.
Step 2: Train the SVM
    $\min 1/2 ||w||^2 + C\Sigma\xi i$
    s.t. $yi(w * xi + b) - 1 + \xi i \geq 0, \xi i \geq 0$ for all i
Step 3: If train data is accurate, performs
    $Fx = a1*x1 + b1*x2....... nx*x_n$
Else
    Preprocess or recheck

Least Square Regression

Step 1: Prepare data based on the matrix and target vector.
Step 2: Calculate coefficients
    $\beta = (XTX)^{-1}* XTy$
Step 3: If train data is accurate, performs
    $Fx = a1*x1 + b1*x2 ....nx*x_n$
Else
    Preprocess or recheck

Neural Network Regression

Step 1: Define Neural network Architecture
Step 2: Train neural network
    Forward Propagation
    Calculate Loss
    Backward propagation
Step 3: Calculates Gradient
Step 4: Optimization Technique
If Optimization technique successful,
    Predict
Else
    Preprocess or recheck

Content Analyzer Algorithm

Step 1: CSV files uploaded
Step 2: Reads the CSV file
Step 3: Accesses each link separately
    If link accessible:
        Content prints
    Else:
        Error Message against link
Step 4: Compile results for each link against defined functions variables
    If results compilation successful,
    Downloads a csv file containing results
Else
    Recheck faulty link

Pseudo Code

K Means Pseudo Code

```
    Input =
    Output = Scatter plot with predicted number of clusters
   For Dataset D,
        Scatter Plot created
        Elbow Method applied
        Verification through silhouette method
  If Elbow method and Silhouette score matches:
       Create n clusters
       Else:
        Recheck Data preprocessing
```

Regression overall Pseudo Code

```
try:
Import necessary libraries
Dataset C
  dataset_clean = load_dataset_C()
 Split dataset into train and test features
  X_train, X_test, y_train, y_test = split_train_test(dataset_w_preprocessed)
Apply Regression code
  regression_model = apply_regression_code()
Calculate R2, Intercept, and key coefficients
  r2, intercept, coefficients = calculate_metrics(regression_model, X_train, X_test, y_train, y_test)
Print R2, Intercept, and key coefficients against features
If Error not found
  print("R2:", r2)
  print("Intercept:", intercept)
  print("Key Coefficients:", coefficients)
Else
  print("Error")
```

Key python components used

The key python libraries used in the codes are shown below

Components	Use
Pandas	For Data Manipulation and Analysis.
Matplotlib	For Plotting Purposes.
Seaborn	Extended version of Matplotlib.
Combinations	For iteration purposes.
Linear regression	Supporting regression model.
SVR	To enable Support vector machine.
Tensor Flow	Supporting Neural Network Process.
DBSCAN	To understand the clustering trends of the dataset.
Beautiful soap	For Web Scrapping Tasks.
NLTK	Framework for understanding human language data.
Stopwords	Common words filtering framework.
Tokenize	For making the components of parts of texts.
YouTube transcript Api	API to access YouTube videos.

Results

Prediction Lexical Density (Simple regression, SVM, Least Square Mean)

```
• Data set without outliers Final.csv(text/csv) - 176802 bytes, last modified: 2/16/2024 - 100% done
Saving Data set without outliers Final.csv to Data set without outliers Final (8).csv
Linear Regression Intercept: 0.9999999999996475
Linear Regression Coefficients:
Lexical Score : 8.094577727571097e-16
Average Word Length : 2.717959321149599e-17
Average Words per Sentence : -4.303604998409649e-17
Readability Ease : -1.0000000000000002
Vocabulary Diversity : 1.7421223774270642e-15
Linear Regression MSE: 9.833352991079083e-22
Linear Regression R^2 Score: 1.0

SVM Regression Intercept: [0.49662733]
SVM Regression Coefficients:
Lexical Score : -0.002095589535520828
Average Word Length : 0.008881342983600264
Average Words per Sentence : 0.00013710034710203095
Readability Ease : -0.03608749889117172
Vocabulary Diversity : 0.0005647594540878576
SVM Regression MSE: 0.0004951836886337689
SVM Regression R^2 Score: 0.8783686976260142

Least Squares Mean Regression Intercept: 0.4938100742299947
Least Squares Mean Regression Coefficients: 0.4938100742299947
Least Squares Mean Regression MSE: 0.004085903430784382
Least Squares Mean Regression R^2 Score: -0.0036149555568176783
```

Prediction Lexical Density (Neural Network)

```
• Data set without outliers Final.csv(text/csv) - 176802 bytes, last modified: 2/16/2024 - 100% done
Saving Data set without outliers Final.csv to Data set without outliers Final (15).csv
19/19 [==============================] - 0s 2ms/step
Ranked Features based on Influence:
1. Feature 3: Mean Normalized Weight = 0.015625
2. Feature 2: Mean Normalized Weight = 0.015625
3. Feature 1: Mean Normalized Weight = 0.015625
4. Feature 0: Mean Normalized Weight = 0.015625
5. Feature 4: Mean Normalized Weight = 0.015624999068677425
Neural Network MSE: 7.117949361364783e-05
Neural Network R^2 Score: 0.9814035463687528
Neural Network Weights:
Layer 1 weights shape: (5, 64)
Layer 2 weights shape: (64, 32)
Layer 3 weights shape: (32, 1)
Neural Network Biases:
Layer 1 biases shape: (64,)
Layer 2 biases shape: (32,)
Layer 3 biases shape: (1,)
```

Prediction Readability Easy (Simple regression, SVM, Least Square Mean)

```
• Data set without outliers Final.csv(text/csv) - 176802 bytes, last modified: 2/16/2024 - 100% done
Saving Data set without outliers Final.csv to Data set without outliers Final (9).csv
Linear Regression Intercept: 0.9999999999998288
Linear Regression Coefficients:
Lexical Score : -9.076954473881107e-16
Lexical Density : -0.9999999999994149
Average Word Length : 4.7660876981159284e-14
Average Words per Sentence : 1.1102230246251565e-16
Vocabulary Diversity : -1.2506543110163415e-15
Linear Regression MSE: 9.831218317229766e-22
Linear Regression R^2 Score: 1.0

SVM Regression Intercept: [0.50310433]
SVM Regression Coefficients:
Lexical Score : 0.002179844408057201
Lexical Density : -0.035961480440935764
Average Word Length : -0.008969204278803914
Average Words per Sentence : -0.00013873633741158314
Vocabulary Diversity : -0.00038714115390063955
SVM Regression MSE: 0.0005025019011129383
SVM Regression R^2 Score: 0.8765711349564618

Least Squares Mean Regression Intercept: 0.5061899257700053
Least Squares Mean Regression Coefficients: 0.5061899257700053
Least Squares Mean Regression MSE: 0.0040859034308855175
Least Squares Mean Regression R^2 Score: -0.0036149555548683487
```

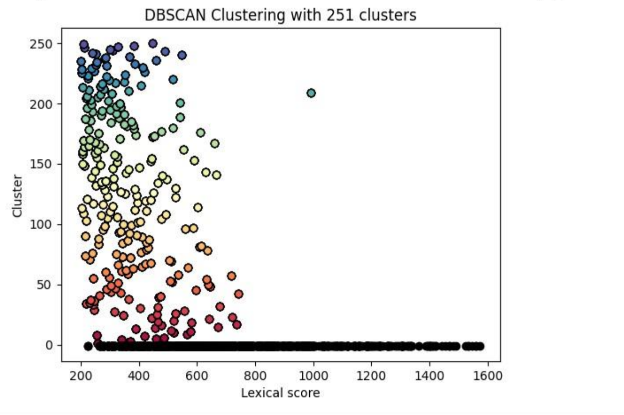
Prediction Readability Easy (Neural Network)

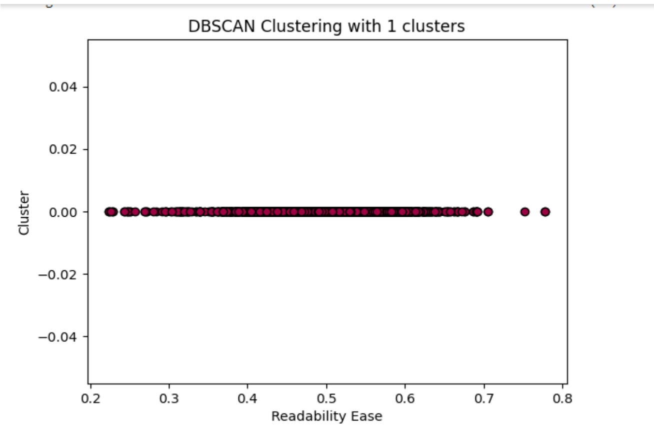
```
Choose Files  Data set wit...rs Final.csv
• Data set without outliers Final.csv(text/csv) - 176802 bytes, last modified: 2/16/2024 - 100% done
Saving Data set without outliers Final.csv to Data set without outliers Final (16).csv
19/19 [==============================] - 0s 2ms/step
Ranked Features based on Influence:
1. Feature 4: Mean Normalized Weight = 0.015625
2. Feature 3: Mean Normalized Weight = 0.015625
3. Feature 2: Mean Normalized Weight = 0.015625
4. Feature 1: Mean Normalized Weight = 0.015625
5. Feature 0: Mean Normalized Weight = 0.015625
Neural Network MSE: 7.655568306168108e-05
Neural Network R^2 Score: 0.9799989556262868
Neural Network Weights:
Layer 1 weights shape: (5, 64)
Layer 2 weights shape: (64, 32)
Layer 3 weights shape: (32, 1)
Neural Network Biases:
Layer 1 biases shape: (64,)
Layer 2 biases shape: (32,)
Layer 3 biases shape: (1,)
```

Multiple Feature Prediction Model

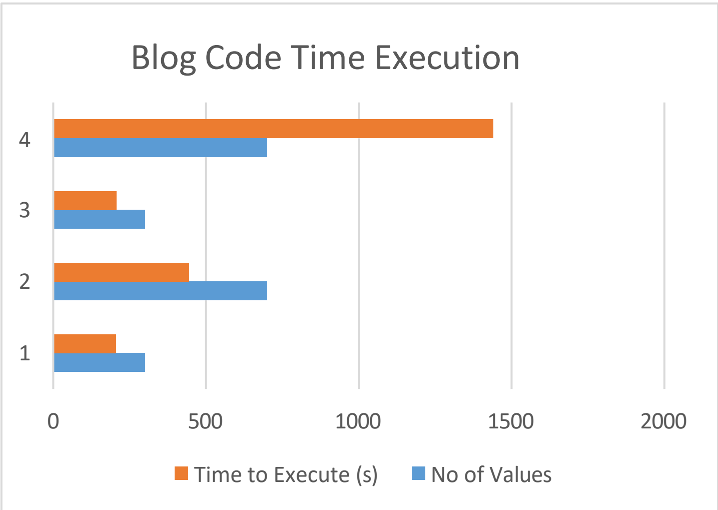
```
• Data set without outliers Final.csv(text/csv) - 176802 bytes, last modified: 2/16/2024 - 100% done
Saving Data set without outliers Final.csv to Data set without outliers Final (7).csv
Linear Regression
Target 1:
Coefficients: [-2.70136686e-05  9.81343711e-02  7.89055479e-06]
Intercept: 0.030577882201212714
MSE: 0.0016470547231678945
R^2 Score: 0.5696881892168225

Target 2:
Coefficients: [-1.39172893e-04  9.74498327e-02 -1.45709079e-05]
Intercept: -0.06529776157877032
MSE: 0.004716188086969039
R^2 Score: 0.48868066455336456

Target 3:
Coefficients: [ 2.70136686e-05 -9.81343711e-02 -7.89055479e-06]
Intercept: 0.969422117798965
MSE: 0.0016470547231696945
R^2 Score: 0.5696881892163523


Ridge Regression
Target 1:
Coefficients: [-2.68615807e-05  9.79320033e-02  7.85563451e-06]
Intercept: 0.031503179127229775
MSE: 0.0016476288814181238
R^2 Score: 0.5695381838327531

Target 2:
```

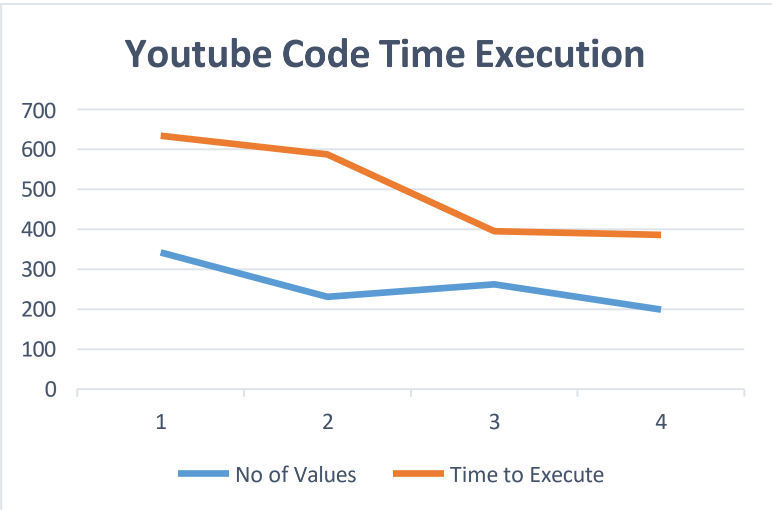
DBSCAN Cluster Analysis





Analyzer Model Performance





Model Performance and explanation

Lexical Score

Model	Intercept	Lexical Density	Average Word Length	Average Word Per Sen	Readability Easy	Vocabulary Diversity	MSE	R^2 Score
Linear Regression	-646.2993	-155	295.3156	0.0527	155.03893	-1037.08	39446.8	0.340841342
SVM Regression	427.0707	3.2019	90.57298	76.617	-3.201881	-77.9258	42719.3	0.286157192
Least Squares Mean Regression	476.0519	476.05	476.0519	476.05	476.05193	476.0519	60014.8	-0.00285176
Neural Network	NA	0.02	0.0156	0.02	0.01563	0.0156	37901	0.377

Lexical Density

Model	Intercept	Lexical Score	Average Word Length	Average Word Per Sen	Readability Easy	Vocabulary Diversity	MSE	R^2 Score
Linear Regression	1	8.09E-16	2.72E-17	-4.30E-17	-1	1.74E-15	9.83E-22	1
SVM Regression	0.496627	-0.002	0.008881	0.0001	-0.0360875	0.000564759	0.0005	0.878368698
Least Squares Mean Regression	0.49381	0.4938	0.49381	0.4938	0.4938101	0.493810074	0.00409	-0.003614956
Neural Network	NA	0.16	0.0156	0.02	0.01563	0.015625	0.00	0.980293

Readability Ease

Model	Intercept	Lexical Score	Lexical Density	Average Word Length	Average Word Per Sen	Vocabulary Diversity	MSE	R^2 Score
Linear Regression	1	-9.08E-16	-1	4.77E-14	1.11E-16	-1.25E-15	9.83E-22	1
SVM Regression	0.503104	0.002179844	-0.03596	-0.008969204	-0.0001387	-0.000387141	0.0005	0.876571135
Least Squares Mean Regression	0.50619	0.506189926	0.50619	0.506189926	0.5061899	0.506189926	0.00409	-0.003614956
Neural Network	NA	0.15625	0.0156	0.015625	0.01563	0.015625	0.00	0.978

Vocabulary Diversity

Model	Intercept	Lexical Score	Lexical Density	Average Word Length	Average Word Per Sen	Readability Easy	MSE	R^2 Score
Linear Regression	0.065212	-0.000129009	0.138475	0.069885371	-1.72E-05	-0.138474803	0.00492	0.500169139
SVM Regression	0.321044	-0.041067498	0.01042	0.038080512	-0.0188254	-0.010420449	0.00497	0.494274788
Least Squares Mean Regression	0.323616	0.323615703	0.323616	0.323615703	0.3236157	0.323615703	0.00985	-0.001780303
Neural Network	NA	0.015625	0.0156	0.015625	0.01563	0.015625	6E-05	0.9841

Key trends from analysis

Starting from the correlation matrix, the variables including Lexical Score, Average words length and Average words per Sentence indicates that texts with higher lexical complexity tend to have longer sentences and words. Conversely, negative relationships between lexical score and readability ease indicate that as text complexity grows, readability decreases. Linear Regress, SVM Regression, Least Mean Square regression and Neural Network were the key Models used for predicting. Main Variables used as predicting variables includes Lexical Scores, Lexical Density, Readability Ease and Vocabulary Ease. Average Word Length and Average Words per Sentence were not used as they were use to derive key variables.

Individual regression analysis in between 2 variables as shown in the Data Analysis Section showed that key results have the tendency to predict accurately. For Lexical Score Prediction, Linear regression reveals a negative relationship, with increased lexical density resulting in lower projected values. In contrast, SVM regression and neural network models paint a more nuanced picture, revealing minor positive associations. Least squares mean regression produces equal predictions across metrics, regardless of lexical density, but with poor fit. The Lexical Density Linear Regression model has a small intercept and coefficients close to zero, indicating limited predictive potential. SVM Regression works well, with an R2 value of 0.878 indicating good fit. Least Squares Mean Regression produces consistent findings across all features but has a negative R2 value, indicating poor performance.

The Neural Network model has the greatest R2 value of 0.98, suggesting good prediction ability. For Readability Ease Linear Regression coefficients are nearly negligible, showing a limited influence of predictors. SVM Regression shows slight predictor influences with a baseline prediction somewhat higher than zero. Least Squares Mean Regression provides consistent predictions independent of predictors, but has a poor fit. In comparison, the Neural Network has relatively tiny coefficients for the majority of predictors, with Lexical Score having a significant influence. For Vocabulary Diversity. Linear regression and SVM regression perform moderately, but least squares mean regression does poorly. The neural network model surpasses other models with a high R2 value of 0.9841, suggesting its improved predictive potential for language variety.

DBSCAN Clustering was also used to see the cluster analysis. Most variable only had one cluster whereas only Lexical Score had 210 clusters. This suggested a less variability in the data and that is why regression analysis using different models had different results with coefficients being very less significant. Neural Network and Support Vector Machine were the two models which tends to predict the key variable accurately

For the Content Analyzer Code, Video algorithm performed better in terms of execution and timing as shown in the bar and line chart earlier.

Recommendations and Future directions

How it can be further Improved?

- Considering more data points from different educational resources.
- Adding more parameters for calculating.
- Coupling the new results with student's key metrics.
- Updating the code and working on the content relevant to schools.
- Advancing the code and enabling OCR capabilities so to read real time writing data and then analyze it as well.

Conclusion

Overall this was a new approach in context of the developing country scenario as to utilize platform based data and do key analysis. Such aspect can be utilized in the institutes of Pakistan as well, which can enhance further the productivity of the students and their learning capability in understanding the subject. This work is just one base point and it can be further enhanced for more domains typically relevant to the education. Key concerns in the data extraction process such as accessibility issues were there but results were generated. Variability of the data was another concern and more variability could have produced more better results. The basic models were utilized and they were enhanced with adding features as well and were joined for one time results as shown in attached results.

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How Much Has Changed? A Bloom's Taxonomy-Based Comparative Evaluation of the 2018 and 2024 English Curriculum for Grade 6

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ABSTRACT

This study aims to presents a comparative analysis of the Turkish 6th grade English curriculum in the context of the 2018 curriculum and the 2024 revised curriculum's goals based on Bloom's Revised Taxonomy. The objectives of both curricula were contrasted in terms of the four major language skills of listening, speaking, reading, and writing. All the goals were coded and sorted based on the six intellectual levels of Bloom's taxonomy: remembering, understanding, applying, analyzing, evaluating, and creating. The findings indicate that both curricula employ predominantly lower-order thinking skills of "remembering" and "understanding." The 2024 curriculum, on the other hand, grapples with more contextually richer and societally more relevant issues such as environmental awareness, emotions, and democratic values. Although it is thematically enhanced, few of the evidence support goals of higher-order cognition of "analyzing," "evaluating," and "creating." Comparative analysis reveals that although the new curriculum provides increased specificity of tasks and richness of content, it does not make the learners cognitively distinctive. Araştırmanın sonuçları, 21. yüzyıl becerileri dikkate alındığında taksonominin bilişsel düzeyleri arasında bir denge kurulması ve öğrencilerin vazgeçilmez üst düzey düşünme becerilerinin her bir dil becerisi için kullanılması gerektiğini ortaya koymaktadır. Bu çalışma, dil öğretiminde daha derin düşünme becerilerini ve eleştirel okuryazarlığı geliştirmek isteyen öğretmenler, politika yapıcılar ve müfredat geliştiriciler için de çıkarımlar üretmektedir.

Keywords – Bloom's taxonomy, curriculum objectives, language skills, 6th grade English curriculum, 2024 Framework Program

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INTRODUCTION

Language has a key role in the realm of human existence since it enables individuals to comprehend and acquire knowledge. The concept in question serves as a metaphorical connection between knowledge and individuals, facilitating the transmission of information through written or spoken means. The utilization of language played a pivotal part in facilitating the emergence of education, which subsequently evolved into a well-structured and widely available system. During the initial stages of education, students acquire the fundamental skills of proper written expression and spoken communication, while also making progress in their listening and reading abilities. Concurrently, the identical approach is implemented in the second language acquisition phase. In the realm of second language acquisition, it is anticipated that students would develop proficiency in four fundamental skills, namely listening, speaking, writing, and reading. In everyday existence, communication refers to the capacity to articulate one's thoughts and ideas through the fundamental and utilitarian aspects of language.

On the other hand, 2018 English curriculum of the Ministry of National Education (MoNE) states that the curriculum encompasses the desired outcomes for students in each course. These outcomes encompass the knowledge, abilities, and attitudes that students are anticipated to gain, in accordance with the specified objectives. This approach serves as a means of guiding educators and parents, offering them insight into the specific linguistic knowledge and skills that children are anticipated to develop (Aksoy, 2020).

Students can examine various materials while learning a second language through a well-designed language curriculum. Yet, learning a new language requires a lot of practice in the four language skills. 2018 Turkish Ministry of National Education 6th Grade English Language Teaching Curriculum was designed according to communicative language teaching principles and was structured to combine language skills with real-life themes. The curriculum consisted of ten thematic units and had 56 learning objectives in four language skills: listening, speaking, reading, and writing. Each was coded systematically (e.g., E6.3.R1 for reading) and stated in measurable, skill-descriptive terms for performance assessment. The 2018 curriculum was designed for simple, functional communication tasks at the developmental levels of the learners and had an emphasis on basic cognitive skills such as remembering and understanding. Although praised for its pragmatism and simplicity, it was criticized extensively for failing to develop higher-order thinking skills or for failing to include 21st-century skills such as critical thinking, creativity, and problem-solving in the language objectives. This version is the point of reference of this study's cognitive analysis.

Regarding listening skills, students must possess the ability to perceive auditory input and grasp the intended message to engage actively in productive communication. Teachers expect that students would comprehend auditory information both within and beyond the educational setting, and engage in effective communication by transforming their listening abilities into meaningful dialogues. In Turkey, the program makers demonstrate a keen focus on the goals and objectives set forth by the Ministry of National Education and develop an educational plan in alignment with these directives. The educational objectives of the curriculum significantly influence the academic term and facilitate teachers in pursuing a substantial progression. The program encompasses a variety of objectives, which are achieved through a range of activities including auditory exercises involving noises, songs, and word pronunciations, among others. To attain proficiency in a foreign language, students must be immersed in an environment where the target language is consistently present. Following the curriculum plan established by the MoNE for the sixth grade, educators may employ a diverse range of instructional strategies and tasks. The course book for this level is the "English Route 6 Course book," prepared by Birincioğlu Kaldar and Karamil in 2021, which was accepted by MoNE on 18.04.2019 to be utilized for 5 years. In the first unit, "Life," there are a lot of tasks and disagreements. At the end of this unit, students should be able to spot phrases, words, and expressions that have to do with actions that are done over and over again (Objective E6.1.L1). The 6th-grade course book states that the tasks include listening to how words are pronounced and understanding dialogues and information, as well as filling in a blank or naming the topic of the dialogue. They also match pictures to what they are hearing or put the pictures in the right order based on what they are hearing. The second unit is "Yummy Breakfast," which mainly focuses on food and beverage names. At the end of the unit, students are expected to identify different food and drink names in an oral text (Objective E6.2.L1). In this unit, students listen to the pronunciations of foods and drinks and match the photos to the numeral system and they are expected to express their likes and dislikes, and they can learn these terms with songs. The third unit is "Downtown". Students are expected to express phrases about present events and compare things. They listen to the words related to the unit and repeat them to pronounce them correctly. They listen to dialogues containing comparative and superlative terms, so they adjust them and use them correctly when they produce the language. The next unit is "Weather and Emotions". In this unit, students are required to "to pick up specific information from short oral texts about weather and emotions" (Objective E6.4.L1). They listen to the pronunciations of weather words, like in previous units, they listen to the text and ask for specific information, and they are expected to match photographs. Also, there are open-ended questions about the text. Unit 5 is “At the Fair” and there are listening activities about emotions, and students are expected to pick them up (Objective E6.5.L1), and match the pieces of information with emotions, which is useful for both objectives that the unit demands. Unit 6, Unit 7, Unit 8 and Unit 9 utilize a similar format of listening activities as previous units utilized. The main objectives of all of these units mainly focus on listening to the pronunciations of words and comprehending these words in an oral text (Objectives E6.6.L1 & E6.6.L2 & E6.7.L1 & E6.8.L1 & E6.8.L2 & E6.9.L1& E6.9.L2). Teachers can benefit from songs, dramas, poems, and tongue twisters to teach this skill, as MoNE suggested in the current curriculum.

Speaking is another crucial aspect of language. In the context of ELT in Turkey, it may be argued that speaking skill is the most intricate and multifaceted capacity. Since 2019, there has been a significant focus on enhancing speaking skills in both primary and secondary schools in Turkey through intensive language programs. In the curriculum and course book created for 6th grade, students are required to engage in spoken dialogue and production. In the first unit, "Life” students are expected “to talk about repeated actions resulting from spoken interaction”. (Objective E6.1.SI1) For spoken production, students “use a series of phrases and simple expressions to express their repeated actions and tell the time and dates” (Objective E6.1.SP1-2). In the course book, illustrations, tables, and conversations are used to achieve the objective. Tasks like drama, songs, and games in the curriculum support learners' speaking improvement. In the second unit “Yummy Breakfast”, it is anticipated that students can “ask about weather”. (Objective E6.2.SI1) For the spoken production section, students are expected “to talk about the weather and their emotions in a simple way” (Objective E6.2.SP1). This unit's activities contain information/opinion gaps, drama, games, and Question and Answer. After the first two units, tasks are set to similar. The third unit is called “Downtown”. In this unit, spoken interaction includes the ability to “ask people what they are doing at the moment” (Objective E6.3.SI1) and compare things (Objective E6.3.SI2). In production, students are to describe different actions that people are doing (Objective E6.3.SP1) and “make comparisons between two things” (Objective E6.3.SP2). Unit 4 is named “Weather and Emotions” in which the objectives are the same as Unit 3. This unit reinforces the purpose of the previous unit. In Unit 5 “At the Fair, the objective of spoken interaction is to “talk and express feelings/opinions about places and things” (Objective E6.5.SI1). In Unit 6 named “Occupations,” students are expected to “talk about occupations for interaction” (Objective E6.6.SI1). In production, they are supposed to “ask personal questions” (Objective E6.6.SP1) and “state the dates” (Objective E6.6.SP2). At the end of the seventh unit “Holidays”, students “talk about holidays for interaction” (Objective E6.7.SI1). Production for this unit is “being able to describe past activities and personal experiences” (Objective E6.7.SP1). The objectives of Unit 8 “Bookworms” are the same as Unit 1. In the ninth unit “Saving the Planet”, student interaction is determined as the objective (Objective E6.9.SI1). The production object of this unit is the same objective as the previous production objections. For the last unit, Unit 10 “Democracy” spoken interaction is the same as other interaction objectives. In the production stage, students are expected “to give short descriptions of events” (Objective E6.10.SP1).

Alongside listening and speaking, writing is an effective tool for the enhancement of language learning. Learners must actively consider grammar, vocabulary, and sentence structure when they are completing writing-related tasks. Writing allows learners to internalize grammar, linguistic norms, and idiomatic expressions, so enhancing their ability to use this knowledge effectively in the course of their language acquisition journey. Therefore, the English curriculum of MoNE places a high importance on the development and mastery of writing abilities. Within the curriculum, there exists a multitude of objectives for each specific talent. For the 6th grade, every unit has objectives and activities according to the unit's topic. In the first unit, “Life”, there is not an objective about writing skills, but there are questions and answers and reordering activities that can relate to the skill. If we examine the second unit named “Yummy Breakfast”, again, there is not a writing skill objective other than question and answer activities. Also, in the third unit, “Downtown” there is not an objective about writing. This unit’s writing-related activities are question-and-answer activities and students are expected to expand their vocabulary by including new items. In the “Weather and Emotions” unit, no objectives can be found about writing skills. As for the activities, there are no other writing-related activities. In the fifth unit, "At the Fair," there is no objective about writing skills. There is a question and answer activity for the activities on the account of writing skills. In the sixth unit entitled “Occupations,” there is the first writing objective of the curriculum, through which students will “produce a piece of writing about occupations and the dates” (Objective E6.6.W1). There is a question-and-answer activity along with the reordering activity. In the seventh unit, which is named “Holidays,” there is an objective that students are to “write short and simple pieces in various forms about holidays” (E6.7.W1). Question and answer, and reordering are the activities that were chosen for this unit. In the “Bookworm” unit, there are two writing objectives, students are supposed to “write about past events with definite time” (E6.8.W1), and “to write about the locations of people and things” (E6.8.W2). The writing activities are question and answer and reordering. Within the ninth unit titled "Saving the Planet," there exists a writing objective that necessitates students' ability to compose concise compositions pertaining to the preservation of the environment (E6.9.W1). Activities that are chosen for writing skills are question and answer and reordering. In the tenth unit, “Democracy,” there is one objective suggesting “writing simple pieces about concepts related to democracy” (E6.10.W1). Question and answer and reordering activities are chosen for the writing skill.

The ultimate component of the curriculum is reading which facilitates the development of fluency through the exposure to various reading paces and the inclusion of relatable everyday life examples. The 2018 Turkish teaching program is designed to impart effective utilization of various skills discussed thus far, as well as enhance social interaction through the application of these skills. Additionally, it aims to improve abilities such as reading, writing, and speaking fluently and confidently in real-time situations, as stated by the MoNE (2019). In a study conducted by Demir (2022), it was found that about half of the outcomes of all skills were related to the reading skill, which supports the fact that reading is an essential part of English learning. The first reading objective of the 6th grade English curriculum (E6.1.R1.) says that the students can understand a short and simple text on personal narratives and repeated acts, and a visual dictionary preparation is advised as an assignment that would require them to read a dictionary to find words they want to use. The second unit is the first unit that has two objectives (E6.2.R1., E6.2.R2). In the first objective, the texts are about foods and preferences, and the second objective says that the students will be able to read the labels of the food products they have learned about. The third unit adds visuals to the texts provided (E6.3.R1.), and it is recommended that students expand their visual dictionary. In the fourth unit, a new topic is introduced and the texts are about weather, its conditions, and human emotions (Objective E6.4.R1.) The fifth unit has two objectives that are faintly related to each other but fully on theme with the unit, which states that the students are to be able to understand the general meaning of simple texts related to feelings and opinions on places and things, (E6.5.R2), which is about reading particular information from a poster about a place. The sixth unit's objective is somewhat different from the rest of the objectives in that familiar words and simple sentences about occupations and dates are understood by the students (E6.6.R1). The seventh unit states that the students must understand brief, simple sentences and expressions related to past actions and tenses (E6.7.R1). Unsurprisingly, yet accordingly, the eighth unit has one objective that is slightly different from the seventh unit's objective via the past related expressions having a definite time (E6.8.R1). The final unit with two objectives is the ninth unit. The first objective (E6.9.R1) is that the students will be able to understand texts on how to protect the environment. The second objective that is different from the former objectives, is that the students are now able to follow written rules and instructions (E6.9.R2). The tenth unit also has goals that are different from the usual ones mentioned above. The final objective states that the students can recognize the words they are now familiar with as well as some phrases related to democracy as a concept (E6.10.R1).

Earlier Studies in Turkey

Analyzing curricula according to Bloom's taxonomy is neither new nor common in Turkey in the secondary school context. Despite the small number of studies, there are still important studies available, one of which was conducted by Kozikoğlu in 2018. The primary objective of this study was to assess the alignment between the objectives outlined in the 8th-grade English Curriculum and the questions included in the TEOG exam, which serves as the national assessment exam. This evaluation was conducted using Bloom's revised taxonomy as a framework. The findings of the research indicated that within the 8th grade English curriculum, a majority of the objectives were classified as "apply" level, with almost half of these objectives specifically targeting the application of procedural knowledge. Nevertheless, Kozikoğlu (2018) discovered that a significant portion of the English course inquiries featured in the TEOG examination mostly targeted cognitive abilities associated with lower-order thinking, such as "remembering" and "understanding." There was a lack of alignment between the learning objectives of the English curriculum and the English course questions in the TEOG examination. The researcher (Kozikoğlu, 2018) proposed a suggested alignment between educational objectives and assessment.

Another important study was carried out by Sönmez (2019) who aimed to examine The Revised Bloom's Taxonomy as a guide for creating the Turkish secondary school curriculum. Several measurement devices were used in various environments as part of the data collection process and it was concluded that the Revised Bloom's Taxonomy can be applied as a model for designing the curriculum (Sönmez, 2019).

In another study conducted by Dalkılıç and Büyükkahiska in 2021, secondary grade curriculum objectives were scrutinized from a broader perspective in terms of the Revised Bloom Taxonomy, in light of previous studies. Three remarkable results were found at the end of the evaluation. The current curriculum advocates lower-order thinking skills most of the time. "Understanding" was the most dominant level in the curriculum. According to Dalkılıç and Büyükahiska (2021), lower-order thinking levels predominantly relied on receptive skills, whilst higher-order thinking skills were primarily employed in productive skills.

Meanwhile, another study done by Gökler, et.al (2012) tried to assess the 8th-grade ELTP curriculum according to Bloom's taxonomy. They included 8 aims, 73 objectives, and 747 written exam copies (Gökler, et. al., 2012). It was found that there were not sufficient aims to fully cover each objective, which left most of them unattained, as it is stated that "Applying" level-related aims were not existent in the curriculum yet existent in exams. It was found that the students were not expected to remember grammatical rules and were not even tested on them in the 2010-2011 fall semester (Gökler, et. al., 2012, p.123). It is clear from the article that the aims and objectives of the 8th-grade teaching program are insufficient and that the students are mostly expected to remember simple sentences and words rather than create a product of this knowledge.

Research Questions

Based on the above information, this paper will focus on 6th-grade English lesson objectives and identify their role in Turkish education programs prepared by MoNE according to Bloom's taxonomy. The curriculum is examined through four research questions stated below:

Q1: What levels of Bloom's Taxonomy are compatible with the listening objectives of the 6th-grade English curriculum?

Q2: What levels of Bloom's Taxonomy are compatible with the speaking objectives of the 6th-grade English curriculum?

Q3: What levels of Bloom's Taxonomy are compatible with the writing objectives of the 6th-grade English curriculum?

Q4: What levels of Bloom's Taxonomy are compatible with the reading objectives of the 6th-grade English curriculum?

METHOD

Research Design

The data of the research were collected through document analysis and subjected to content analysis. By taking advantage of a qualitative approach, the present study examines the 6th-grade English curriculum objectives and indicates the results for these four skills.

Data Collection

The 2018 6th-grade English Curriculum and the 2024 Framework Program of the Minister of National Education taken from MoNE's website was utilized as the main source of data in the study. Using the 2018 6th grade English curriculum as the point of analysis for conducting the research was based on the fact that it is an earlier and comprehensive set of learning aims preceding the 2024 reforms. Inasmuch as the revised model incorporates some lexical and thematic reform, it retains the essence of the 2018 curriculum's underlying coding and organizational schematics. A diachronic analysis enables a more effective evaluation of whether revised curricula entail substantial pedagogic change or are limited to surficial revision. On that basis, the present work starts by conducting a comprehensive cognition analysis of the 2018 objectives based on the Revised Taxonomy of Bloom, followed by a comparative reading of the 2024 editions to determine whether shifts occur with respect to language, focus, or cognition.

Additionally, the revised Bloom taxonomy was also used as the reference point which helped the researchers identify the objectives according to the cognitive domains of the taxonomy.

*Revised Bloom's Taxonomy***.** In order to assess these abilities, this study employs Bloom's revised taxonomy, a hierarchical framework for categorizing cognitive processes into six levels of complexity (Forehand, 2005). According to Bloom's taxonomy, traits are intended to be given to an individual through education and teaching. The cognitive field is about knowledge which involves recognizing, understanding, and using information (Doğanay and Sarı, 2017). Most prominent in the new editing is that the one-dimensional structure of the cognitive field is brought into a two-dimensional shape (Krathwohl, 2002). Bloom and his colleagues originated the taxonomy to classify educational goals in line with the cognitive domains of the learners in 1956 (Bloom, 1956). From simple to complex, from abstract to concrete, Bloom and his associates' initial taxonomy was divided into categories. During the 1990s to add relevance for 21st-century students and teachers, the taxonomy was revised. The revision was published in 2001 and includes minor yet vital changes (Forehand,2005). The new terms are defined as:

● Remembering: Retrieving, recognizing, and recalling relevant knowledge from long-term memory. "Define", "find" and "choose" are a few instances of verbs that indicate "Remembering" level objectives.

● Understanding: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining. "Classify", "compare" and "contrast" are some verbs that show "Understanding" level objectives.

● Applying: Carrying out or using a procedure through executing, or implementing. "Apply", "build" and "utilize" are some verbs that show the "Applying" level.

● Analyzing: Breaking material into constituent parts, determining how the parts relate to one another and an overall structure or purpose through differentiating, organizing, and attributing. "Analyze", "assume" and "categorize" are the verbs that are at the "Analyzing" level.

● Evaluating: Making judgments based on criteria and standards through checking and critiquing. "Agree", "asses" and "compare" are a few instances of verbs that show the "Evaluating" level.

● Creating: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing. "Adapt", "build" and "change" are some verbs that indicate "Creating" level objectives (Anderson & Krathwohl, 2001, pp. 67-68).

By using this taxonomy as its basis, this paper aims to analyze the skills objectives of MoNE and understand which level of taxonomy they serve; and to show it visually employing quantitative methods and statistical analysis of data.

Data Analysis

The study employed a descriptive analysis model to identify the alignment of the objectives with Bloom's revised taxonomy. A comprehensive examination of a total of 56 objectives of the English curriculum for the sixth grade was conducted in two stages. First, an extensive review of relevant literature pertaining to Bloom's taxonomy was conducted. Subsequently, an assessment was made to ascertain the specific skill domain in which the objectives of the 6th-grade English curriculum were identified, as well as the corresponding cognitive level as classified by the taxonomy.

The second stage of the investigation determined which acquisition occurred at which cognitive level. The literature review was conducted to establish the cognitive level and identify the verbs associated with each phase. These verbs were subsequently utilized in the analysis. The data indicated in the tables are summarized descriptively using frequencies. Each researcher worked individually first and then compared their checklists with each other, and an expert opinion was additionally received at the end to ensure the reliability and validity of the research.

FINDINGS

The 2019-2020 school year curriculum for the 6th grade English course includes a total of 56 objectives. Thirteen of the these belong to reading skill, while twenty are about speaking, six are writing, and the remaining thirteen are listening.The program's 56 objectives are individually addressed in accordance with the corresponding cognitive levels of the Revised Bloom Taxonomy.

Analysis of Listening Objectives

The analysis of the sixth-grade listening objectives (n=13) is shown in Table 1, along with an illustration of the levels to which each objective relates, conforming to the revised Bloom's taxonomy. The levels delineated below are predicated on the principal cognitive emphasis of each objective.

Table 1: Analysis of Listening Objectives of 6th Grade According to Bloom's Taxonomy

Objectives	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
E6.1.L1.	X					
E6.2.L1.	X					
E6.3.L1.	X					
E6.3.L2.	X					
E6.4.L1.	X					
E6.5.L1.	X					
E6.6.L1.	X	X				
E6.6.L2	X	X				
E6.7.L1.	X					
E6.8.L1	X	X				
E6.8.L2.	X	X				
E6.9.L1.					X	
E6.9.L2.					X	
f	11	4	0	0	2	0

Most of the learning goals for listening are at the lower levels of Bloom's Taxonomy, especially "Remembering" and "Understanding." This means that the main focus should be on how well students can remember and understand information from speaking texts, as well as how well they can pick out specific details and recognize phrases and expressions. Out of 13 objectives, 11 of them are related to "Remembering", 4 of them are in the "Understanding" level, and 2 of them align with the "Evaluating" level. It is obvious that %84,6 of the objectives that aim at improving listening skills are "Remembering" and the least focused levels are "Creating", "Applying", and "Analyzing". Even though it seems like the curriculum gives students chances to use and analyze knowledge in an auditory setting, these goals are not stated directly. In addition, the program has two goals that align with the "Evaluating" level. These goals focus on students' ability to recognize the right attitudes and suggestions for protecting the environment. Bloom's Taxonomy's top level, "Creating," does not have any specific goals that match up with it. This shows that the curriculum aims to develop the receptive listening skill but without offering opportunities for higher-order thinking in auditory situations. In the revised 2024 curriculum, while the coding and general format of the listening objectives are very much the same, some rewording and change in theme can be observed. New objectives still focus on recognition and identification but with rather more elaborated contexts such as environmental awareness or emotions. However, these additions do not substantially move the cognitive demand of the objectives. Most remain in the lower levels of Bloom's Taxonomy, and no new objectives are formulated to promote critical or creative listening. So, although the revised program introduces contextual accuracy, it does not substantially enhance the cognitive engagement of listening outcomes.

Analysis of Speaking Objectives

In Table 2, the 6th grade English curriculum speaking objectives (n=20) are analyzed in line with Bloom's taxonomy. Each objective is matched to a suitable level to show the diversity of the levels of the speaking objectives, including at least one objective from each unit.

Table 2: Analysis of speaking Objectives of 6th Grade According To Bloom's Taxonomy

Objectives	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
E6.1.SI1.	X					
E6.1.SP1.		X				
E6.1.SP2.		X				
E6.2.SI1.	X					
E6.2.SP1.			X			
E6.3.SI1.	X					
E3.3.SI2.	X					
E6.3.SP2.		X				
E6.4.SI1.	X					
E6.4.SP1.		X				
E6.5.SI1.	X					
E6.5.SP1.		X				
E6.6.SI1.	X					
E6.6.SP1.		X				
E6.7.SI1.	X					
E6.7.SP1.			X			
E6.8.SI1.	X					
E6.8.SP1.			X			
E6.9.SI1.	X					
E6.10.SP1.	X					
f	11	6	3	0	0	0

As is the case in the listening curriculum, the main goals of the speaking curriculum are mostly related to the lower levels of Bloom's Taxonomy, especially "Remembering" and "Understanding." There are 20 objectives and 11 of them are designed at the "Remembering" (%55) level while 6 of them align with the "Understanding" (%30,) level, and only 3 of them are found at the "Applying" (%15) level. Bloom's Taxonomy shows that no specific goals match the "Applying" and "Analyzing" levels. These goals focus on the student's ability to remember and understand knowledge about a wide range of topics. One thing that stands out is that there aren't many goals at the "Applying" and "Analyzing" stages. Also, at the

"Evaluating" and "Creating" levels, which require higher-order thought and creativity, there are no specific goals. The 2024 syllabus continues this overall trend but makes a subtle change in communicative orientation. Although the cognitive level of the objectives generally stays the same, there is a more distinct separation between spoken interaction and spoken production, and speaking task conditions are elaborated with functions such as making suggestions, comparing tastes, and giving opinions. All these are intended to promote more purposeful and interactive oral communication. But for all such thematic extensions, the new objectives remain in the lower-order thinking categories, with no apparent move to analytic or creative application of spoken language. The new curriculum, then, increases functional variety in speaking activities but not so much their intellectual complexity.

Analysis of Writing Objectives

In Table 3, the writing objectives (n=10) of the 6th grade English curriculum's all units are shown in line with Bloom's Taxonomy. Every object is linked with at least one level of Bloom's Taxonomy. Table 3 shows Bloom's Taxonomy's levels and its compatible objectives from the 6th-grade English curriculum.

Table 3: Analysis of Writing Objectives of 6th Grade According To Bloom's Taxonomy

Objectives	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
E6.6.W1.	X					
E6.7.W1.		X				
E6.8.W1.		X				
E6.8.W2		X				
E6.9.W1.		X				
E6.10.W1.		X				
f	1	5	0	0	0	0

As Table 3 shows, similar to the speaking and listening courses, the main goals of the writing curriculum are at "remembering" and "understanding" levels. 83,3% of the objectives concentrate on "Understanding" and 16,6% of the objectives concentrate on the "Remembering" level of Bloom's Taxonomy. It is noteworthy that the stages of "Applying" and "Analyzing" do not possess any explicit objectives. Students would be more likely to think critically and use their knowledge in real-world situations if their goals involved applying writing skills to real-world situations. At the "Evaluating" and "Creating" levels, which require higher-order thought and creativity, there are also no clear goals. Whereas in the 2024 curriculum the targets of written work grow marginally and the activities are more specified—e.g., writing about past experiences, personal experiences, or environmental issues—cognitive demand remains low. Most of the writing activities are again focused on the transmission of plain ideas or the provision of factual knowledge. Although these could be beneficial to students in fluency and basic organizational skill development, they are not ideally suited to argument, synthesizing, or creative writing. Inclusion of relevant subject matter of a socially oriented nature is a strength for content value, but raising the cognition level of writing tasks beyond prior levels is not met. Changes in 2024 thus improve contextual content but neglect to produce higher levels of writing competency at upper levels of Bloom's Taxonomy.

Analysis of Reading Objectives

Table 4 displays the compatibility of the objectives of the 6th grade English reading curriculum (n=13) with the levels of Bloom's Taxonomy.

Table 4: Analysis of Reading Objectives of 6th Grade According To Bloom's Taxonomy

Objectives	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
E6.1.R1.		X				
E6.2.R1.		X				
E6.2.R2.	X					
E6.3.R1.	X					
E6.4.R1.		X				
E6.5.R1.		X				
E6.5.R2.	X					
E6.6.R1.	X					
E6.7.R1.	X					
E6.8.R1.	X					
E6.9.R1		X				
E6.9.R2.	X					
E6.10.R1.		X				
Total	7	6	0	0	0	0

The majority of the reading curriculum's goals are in line with Bloom's Taxonomy's lower levels, especially "Remembering" and "Understanding". 53,84% of the objectives are in line with the former, whilst 46,15% of the objectives are in line with the latter. These goals emphasize students' capacity for information retention, text comprehension, and word recognition. While these goals are essential for increasing reading fluency, there is room for higher-level goals that would encourage more sophisticated reading comprehension and critical thinking. As the table portrays, there are no other levels of the pyramid that any of the objectives align with. The absence of objectives at the "Applying" and "Analyzing" levels is one noteworthy finding. At the "Evaluating" and "Creating" levels, which require higher-order reasoning and creativity, there are, again, no set objectives. In the 2024 revised curriculum, cognitive orientation is unchanged but some objectives are made more specific in vocabulary and scope. The addition of objectives like comprehending product labels or reading brief written instructions gives functional daily applications of reading. These changes imply a modest move in the direction of functional literacy but within the confines of "Understanding" and straightforward "Applying.". Overall, then, the 2024 curriculum presents reading inputs that are richer in context but still doesn't present objectives that engage students in textual analysis or evaluation of a higher order. In this manner, it still values comprehension and recognition more than critical engagement with texts.

Overall Results

The present study examines the distribution of learning objectives in accordance with Bloom's Taxonomy within the analyzed dataset.

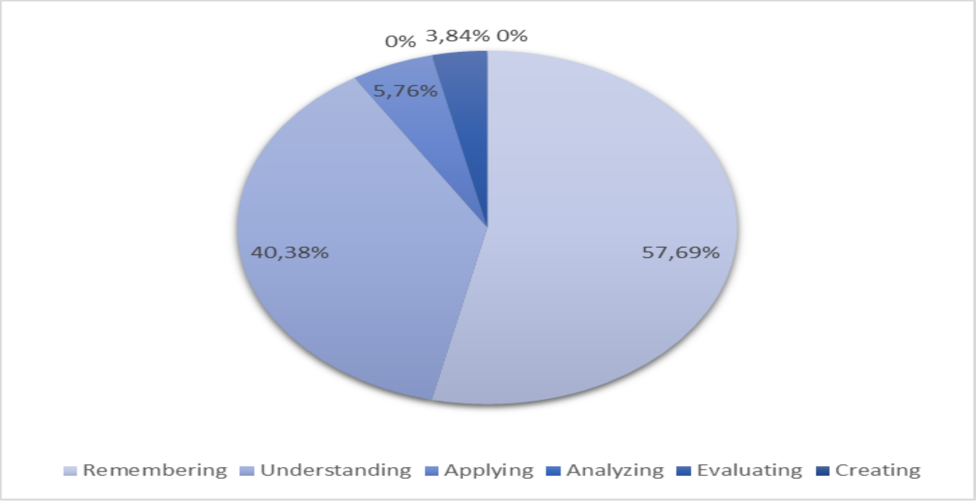

Figure 1. Distribution of the objectives according to the levels of the taxonomy.

The analysis revealed that the majority of objectives pertained to the Remembering category, constituting 57.69% of the total objectives (n = 30). Following this, the Understanding category encompassed 40.38% of the objectives (n= 21), while Applying represented a smaller proportion at 5.76% of the objectives (n = 3). Notably, objectives categorized under Analyzing were absent from the dataset, and Evaluating accounted for 3.84% of the objectives (n= 2). Conversely, no objectives were classified under the Creating category. These findings underscore the predominant focus on Remembering and Understanding levels of cognitive engagement in the instructional design, with limited emphasis on Applying and Evaluating levels, and a notable absence of Analyzing and Creating levels within the specified dataset.

DISCUSSION AND CONCLUSION

In education, objectives play a crucial role in determining how to educate, how the learning and teaching settings will function, and how the final results will be guided (Hamurcu & Ekinci, 2020). As the results show, the objectives of the listening skill mostly correspond to the "Understanding" and "Remembering" levels of Bloom's taxonomy. The course book contains different activities, such as listening to a text and completing a blank according to a piece of information that students hear; and listening to songs about the unit's words and pronunciations. The course book comprises nearly every unit in the same structure of activities, which might be monotonous or boring. While these activities are suitable to meet the objectives, they are not enough which is in line with the literature (Dalkılıç & Büyükahiska, 2021). Meanwhile, the ability to speak successfully stands out in every language curriculum. In our context, the most frequently used level is remembering while creating and evaluation levels are the least, which is disputable. Students should be able to express themselves in the target language at an A1 level by the end of the sixth grade. Therefore, the course book's exercises and assignments are well-suited to the skill level of the students using them. However, after the first couple of courses, students may find the exercises and tasks to be repetitive and tiresome, therefore, to stimulate the speaking production of younger learners, speaking objectives in the curriculum can be revised according to the last two steps of Bloom's taxonomy pyramid.

The results of the study also revealed that writing skill has the fewest objectives among all the skills. Still, these objectives are quite effective for learners to practice their writing skills. When performing writing-related tasks, learners need to actively take grammar, vocabulary, and sentence structure into account. Learners can effectively use syntax, language rules, and idiomatic expressions throughout their language-learning process via writing if the objectives are designed this way.

Finally, it is apparent from the results of the study that Turkish curriculum designers did take into account the fact that reading is crucial for the mental, social, and academic improvement of students. However, the objectives are most aligned with the “Understanding” level of Bloom’s taxonomy and the fact that there is no emphasis on high-order thinking skills weakens the efficiency of the curriculum.

Overall, the current curriculum advocates lower-order thinking skills most of the time, and “Remembering” was the most dominant level in the curriculum. As was also discovered by Dalklç & Büyükahiska (2021), lower-order thinking levels mostly consulted receptive skills, while higher-order thinking levels were primarily used to productive skills. Additionally, there were not sufficient aims to fully cover each objective, which left most of them unattained, which was also implied by Gökler, et. al., (2012) and the fact that there is limited emphasis on Applying and Evaluating levels, and a notable absence of Analyzing and Creating levels within the specified dataset constitutes the weakest side of the current curriculum.

It is also important to note that, the new 2024–2025 English Language Teaching Framework introduced by the Turkish Ministry of National Education are mostly in line with the results of the present study, yet, there are still some impressive innovations that squarely address some of the cognitive imbalances emphasized in this study. In contrast to the 2018 version, the revised curriculum overtly includes outcome statements framed on higher-order thinking skills such as "Analyzing," "Evaluating," and "Creating." A few examples of some new 6th-grade objectives are task-based, open-ended learning experiences such as making presentations, creating posters, comparing viewpoints in conversations, and resolving real-life issues in group activity. These tasks encourage language use beyond recognition and recall, facilitating cognitive transfer and genuine communication. Moreover, the new framework includes performance-based standards of evaluation and further stresses digital literacy, intercultural competence, and socio-emotional communication—abilities submerged or implicit in the former curriculum. These changes signal that upcoming curriculum assessments should no longer merely examine the frequency of cognitive levels but also task complexity and authenticity, the presence of transversal competencies, and alignment with CEFR-based communicative competences.

Suggestions

To make a more balanced and complete listening program, teachers could try to change the cognitive levels of the goals. By using goals from different levels of Bloom's Taxonomy, students can use a wider range of mental processes, which helps them understand and remember the information better. Educators can learn more about their student's ability to understand what they hear and think critically by asking questions that target different brain levels. Lastly, the curriculum should move from easy tasks like recognizing words and phrases to more difficult ones like understanding historical events and judging how people feel about environmental issues. Teachers can use this progression to build up learning situations and help students get better at understanding what they hear. Adding goals at higher levels would also help students learn how to think more deeply and solve problems.

The currently offered speaking curriculum could be expanded to include more types of public communication, such as debates, role plays, interviews, and presentations, among others. Students would be able to improve their flexibility and fluency in spoken language by speaking in a variety of situations and settings. Having goals based on group talks, teamwork, and interactions with peers has the potential to create a productive and interesting learning environment. Collaboration jobs encourage active participation and give students the chance to learn from each other by sharing ideas and points of view. Teachers can add real-world oral communication assignments to the curriculum to make it more meaningful. Also, students could learn more about other cultures and be more sensitive to them by putting cultural aspects into speaking tasks and taking context into account. Students' communication skills would improve if they are encouraged to change how they use words depending on the situation and who they are talking to.

When developing a more complete writing curriculum, teachers should think about integrating objectives that demand analytical and creative thinking. Teachers and students can enhance their abilities to analyze content, assess ideas, and produce essays with a range of perspectives by combining objectives that promote higher-order thinking. A writing program that maintains cognitive equilibrium may be more beneficial and rewarding. A clear transition from easier writing assignments, such as writing about employment, vacations, and historical events, to more challenging ones, like evaluating and synthesizing material or expressing personal viewpoints, should be used in the writing curriculum. By including components for reading, speaking, and other language skills, the writing curriculum could be improved. This integration helps students apply their language abilities in a variety of circumstances and enhances their overall language development.

To develop a more thorough reading curriculum, teachers should think about including objectives that call for students to analyze texts, assess content, and take part in imaginative and reflective activities related to the readings. Students can have a deeper grasp of the texts and improve as readers by balancing their cognitive levels. There should be a clear development in text complexity for the reading curriculum. Students' reading skills ought to be developed in a scaffolded way by starting with straightforward texts describing common behaviors and preferences and progressively introducing more difficult themes and structures. Although the curriculum might explicitly include reading skills to assist students become more proficient readers, the objectives emphasize comprehension and recognition, which are greatly important yet not enough by themselves. It was shown in a recent study

(Sönmez, 2022) that interactive reading and repeated reading are both considerably effective ways of influencing reading comprehension, which is also supported by Stahl (2003). The curriculum can be made more relevant and interesting for students by using actual texts, such as news items, ads, or literary excerpts. As a result, students would be exposed to actual language use and cultural nuances through authentic materials. In short, teachers can develop a more thorough and dynamic reading curriculum that encourages students' reading comprehension abilities, critical thinking skills, and a love of reading by taking both content and classroom methodologies throughout the curriculum design and implementation process without being too prescriptive or all-inclusive. Achieving a balance between cognitive levels will act as a guide for teaching and learning and finally enable students to develop into more capable readers who can successfully navigate a range of texts.

Statements of Publication Ethics

The authors state that their work is not subject to ethics committee approval and declare that the rules set by the Committee on Publication Ethics (COPE) have been complied with throughout the entire process of the study.

Conflict of Interest

The authors declare that there is no conflict of interest with any institution or person within the scope of the study.

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