

# Study on the effectiveness of speech-to-text technology in supporting writing skills among special education students in Saudi Arabia

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**Abstract:** This study aims to assess the efficacy of speech-to-text (STT) technology in improving the writing abilities of special education pupils in Saudi Arabia. A deliberate sample of 150 special education college students was selected, with participants randomly allocated to either an experimental group employing STT technology or a control group using traditional writing methods. The study utilized a comprehensive approach, which included standardized writing assessments, questionnaires, and statistical analyses such as t-tests, correlation, regression, ANOVA, and ANCOVA. The results demonstrate a substantial enhancement in writing skills among the experimental group utilizing Speech-to-Text (STT) technology. The findings contribute to the discussion on assistive technology in special education and offer practical recommendations for educators and policymakers.

**Keywords:** speech-to-text technology; special education; writing skills

## 1. Introduction

Current research emphasizes the significance of personalized treatments and assistive technologies for kids with special educational needs. As stated by Rose (2021), providing personalized assistance is crucial for meeting various learning needs, which requires innovative solutions. Hong and You (2022) concur with this viewpoint, emphasizing that assistive technologies can empower students with impairments and enhance their academic achievement. In addition, Smith (2020) highlights the profound impact of assistive technology in special education, providing essential support for a range of learning difficulties.

The focus of this study is on a particular assistive technology called Speech-to-Text (STT) and its potential impact on the writing skills of kids in special education. Recognizing the important role of assistive technologies in promoting inclusive education, as identified by the World Health Organization (WHO, 2023), this study proposes that Speech-to-Text (STT) technology can help create an inclusive learning environment by addressing writing challenges. According to Smith and Jones (2022), and further corroborated by Miller and Davis (2021), the successful utilization of assistive technology can enhance the acquisition of essential skills among college students with varying learning requirements.

To facilitate clarity and maintain consistency in the understanding of standards, this study operationally defines numerous essential words. Speech-to-Text (STT) technology is a computer-based system or program that transforms spoken language into written text, enabling anyone to create written information using spoken words (Johnson et al., 2020). Special Education Students refer to persons within the Saudi Arabian education system who have been identified with various learning needs, including but not limited to cognitive, sensory, motor, or socio-emotional difficulties

(Al-Rashdi and Al-Azawei, 2019). Writing skills refer to the capacity to effectively convey ideas, thoughts, and information through written language, encompassing elements such as syntax, spelling, organization, and logical consistency.

This study aims to provide practical insights into the use of Speech-to-Text (STT) technology as an assistive aid by focusing on writing skills. The need to investigate the efficacy of the Science, Technology, and Telecommunications (STT) period in Saudi Arabia is emphasized due to the little research conducted inside the country's educational sector. The Saudi Vision 2030, which outlines the national goals, places significant importance on enhancing the education system and ensuring equal opportunities for all learners. In line with this vision, this study explores the specific needs of kids in special education, providing evidence-based insights that can guide educational policies and practices.

Furthermore, given the rapid advancements in global technology and the widespread use of Speech-to-Text (STT) technology in mainstream education (Kim et al., 2023), it is crucial to have a detailed understanding of its practical consequences in the field of special education in Saudi Arabia. This study aims to close this gap by providing a practical analysis of the potential benefits and challenges associated with the integration of STT technology. By doing these studies, the goal is to provide educators, policymakers, and academics with practical data to enhance the learning experiences of kids in special education.

### **1.1. Problem statement**

The unique training sector in Saudi Arabia is now facing a significant challenge in terms of enhancing the writing skills of its pupils. The difficulties faced by special education kids in acquiring writing skills are complex, involving cognitive, motor, and socio-emotional aspects. Current educational methods, while thorough, may not fully meet the specific needs of this diverse student population, requiring a more thorough examination of creative solutions. An intervention that warrants examination is the integration of speech-to-text (STT) technology. Although assistive technologies are becoming more widely used in regular schools worldwide, there is a noticeable absence of research that particularly assesses the effectiveness of speech-to-text (STT) technology in improving writing skills among special education students in Saudi Arabia.

### **1.2. Research questions**

- 1) What is the impact of speech-to-textual content generation on the writing talent development of unique training college students in Saudi Arabia?
- 2) Are there good-sized differences in the writing performance of special education students using speech-to-text generation as compared to the ones using conventional writing strategies?
- 3) How do teachers understand the effectiveness of speech-to-text technology in facilitating the writing competencies development of unique schooling college students in Saudi Arabia?

### **1.3. Significance of the study**

This observation is of utmost significance in the context of special education in Saudi Arabia. With the educational device evolving and incorporating technological advancements, educators, policymakers, and academics must comprehend the effectiveness of speech-to-text production. The results of this study are positioned to provide empirical evidence that can inform the creation of evidence-based treatments customized to the specific requirements of special education kids. The results of the study will add to the existing literature on speech-to-text technology. Special education teachers can benefit from the results when they intend to implement this technology in their classrooms. Moreover, the examination is in keeping with the broader educational objectives stated in Saudi Vision 2030, which highlights the need to provide equitable opportunities and high-quality education for all students, including those with diverse learning needs.

### **1.4. Limitations of the study**

This study aims to investigate the influence of speech-to-text technology on the writing skills of special education students in Saudi Arabia. However, it is important to acknowledge some obstacles that need to be addressed. The findings may have limited generalizability due to the exclusive emphasis on a specific group within the Saudi Arabian environment. Furthermore, the dependence of the take a look at on quantitative procedures may not fully include the entire range of evaluations and impressions. In addition, external factors such as socio-economic pressures and disparities in access to technology may introduce confounding variables that are outside the scope of this research. These limitations are acknowledged as crucial elements of the study's scope and methodology, providing opportunities for future research to further explore the complexities of the topic.

## **2. Literature review and previous research**

Children who struggle with handwriting may find speech-to-text (STT) technology helpful since it allows them to dictate, revise, and evaluate their work using voice instructions instead of typing, which eliminates the need for transcription. Students' ability to express themselves on screen and their ability to carry that progress over to their written work are both aimed at by these systems (Smith and Davis, 2023). The direct and indirect effects model of developmental writing and other recent models rely on research that is both cross-sectional and longitudinal. It is necessary to prepare, translate, and edit when writing (Wilson and Watson, 2021). Transcription includes both spelling and handwriting, just as translation encompasses language creation. Students in the middle of the primary school year still lack complete handwriting fluency. Similar to how phonological, ethnographic, and morphemic aspects contribute to spelling's complexity, the development of this talent persists throughout primary school. There is competition for working memory among these several writing processes (Lewis et al., 2024). This may explain why transcribing procedures are strong indicators of future writing success. Instructional studies demonstrating that handwriting treatments enhance text quality and writing fluency lend credence to the causal significance of transcribing abilities in composition. Just

as some studies have shown that teaching students to spell has improved text quality, others have found the opposite to be true.

Studies have shown that STT is useful when combined with continuous speech recognition. Writing essays was a three-pronged task for secondary school pupils, including those with and without learning impairments (LD). Dictation produced better overall quality than STT, which was better than handwriting, for LD pupils (Harper and Lee, 2024). None of the three methods had significantly different impacts on non-LD kids. The authors concluded that STT has the potential to be a useful test accommodation. Similarly, for an interaction effect for younger, less experienced writers (11–14 years old), STT allowed them to produce lengthier texts with fewer mistakes than handwriting. However, for older, more experienced authors, there was no discernible influence of production mode. Neither group showed a discernible change in holistic quality. Students' greater usage of terms with seven letters or more mediated the positive effects of STT on holistic quality (Rose, 2021).

The cognitive theory of multimedia learning put forward by Mayer (2014) seeks to account for how information is assimilated when delivered in various formats. Different regions of the brain are responsible for processing visual and linguistic information, and so goes the hypothesis. While the visual channel receives information primarily via the eyes and then generates visual representations, the verbal channel receives information mostly through the ears and then generates verbal representations (Smith and Jones, 2021). A student listens intently to a spoken phrase, breaks it down into its parts, stores it in verbal working memory, and finally verbalizes those parts. Words are then conceptually linked into cause-and-effect chains following this procedure. In a similar vein, during learning, a person's visual cues are carefully considered, and they choose pictures to store in their visual working memory. Educators may find various rules to follow while using multimedia in the classroom from the cognitive theory of multimedia learning (Williams and Clarke, 2023). The concepts of contiguity, modality, redundancy, and expertise reversal are of special importance for this investigation. The contiguity principle states that the optimal delivery of multimedia is concurrent rather than sequential. Meaningful learning can occur when information is acquired all at once because children can form associations between the verbal and visual representations in working memory (Thompson and Black, 2024).

The latest research, such as the one conducted by Burgstahler and Cronheim (2019), emphasizes the changing landscape of assistive technology and its growing incorporation into special education curricula. The authors underscore the importance of taking into account individual preferences and options when selecting appropriate assistive equipment. This study examines the proficiency level of various technologies, such as speech-to-text, in addressing writing difficulties among diverse students at educational institutions. Speech-to-text technology, a component of assistive technology, has attracted attention due to its potential to aid college students in the process of writing. A study conducted by Johnson et al. (2020) examined the impact of speech-to-text technologies on the written expression abilities of students with learning difficulties. The findings suggested a beneficial correlation between the utilization of speech-to-text technology and improvements in writing fluency and composition.

Similarly, Smith and Jones (2021) examined the advantages and limitations of speech-to-text technologies in educational environments. Their research emphasized the positive influence of speech-to-text technology on the writing process, particularly in terms of enhanced efficiency and decreased cognitive burden for students with diverse learning requirements. Nevertheless, the report also emphasized the importance of proper education and continuous assistance for effective implementation. Enhancing writing skills is a substantial endeavour for kids in special education. The study conducted by Chen et al. (2018) investigated the particular challenges experienced by students with language-based learning impairments in the field of writing. The examination highlighted the need for specific interventions to enhance writing skills and suggested that assistive technology, such as speech-to-text, may offer personalized assistance.

In addition, a thorough meta-evaluation conducted by Rodgers and Loveall (2023) analyzed several strategies to improve writing outcomes in special education. The assessment underscored the possibility of treatments based on different periods and stressed the necessity for more investigation into particular tools such as speech-to-text technology to enhance writing skills among special education groups. In Saudi Arabia, the implementation of assistive technology in special education has been shaped by changing educational regulations. Al-Rashdi and Al-Azawei (2019) conducted a study to assess the current level of usage of assistive technology in special education classrooms in Saudi Arabia. The observer acknowledged the increasing acknowledgement of technology's role in addressing various learning needs and advocated for further efforts to effectively incorporate assistive tools.

### **3. Methods**

The research employed a planned sample technique to selectively choose individuals from specialized educational facilities in the Saudi Arabian environment. A comprehensive group of 150 kids in special education was enrolled, ensuring a representative distribution across different grade levels and individualized learning requirements. These students have several types of disabilities, mental and physical. Following that, participants have been randomized at random to either the experimental group, which utilizes speech-to-text (STT) technology, or the control group, which uses conventional writing methods. Each student and their respective parents or guardians carefully obtained informed permission, with the ethical concerns of the study receiving clearance from the relevant institutional review board.

The primary instrument utilized for data collection was transformed into a well-crafted standardized writing evaluation tool. This test enabled a comprehensive evaluation of several areas of writing proficiency, including grammatical precision, spelling proficiency, organizational structure, and overall coherence. Alongside this evaluation tool, a thorough survey was conducted on both the experimental and control groups, capturing the subtle impressions of students regarding the effectiveness of STT technology in enhancing their writing abilities. In addition, instructors involved in the experimental organization were consulted to get their thoughts on the noticeable impact of STT production on the writing performance of their college students.

To protect the reliability of the devices used, a pilot study was conducted using a

smaller group of distinct trainees ( $n = 20$ ) selected from the main research population. The questionnaire was developed by the researcher and validated by consulting experts in special education. The impact of the pilot study was subjected to a thorough review, resulting in revisions to the assessment instrument and survey questions, guided by the feedback obtained from participants.

Descriptive information, including means and standard deviations, has been computed for both pre-test and post-test ratings within each experimental and control group. The t-test was ultimately used to determine significant differences in mean writing performance scores between the two groups. Correlation analysis was used to examine the association between the use of STT technology and enhancements in writing skills. Furthermore, regression analysis has become crucial in examining the predicted impact of many parameters on the effectiveness of speech-to-text technology.

Moreover, an analysis of variance (ANOVA) was carefully utilized to assess the impact of different grade levels on the writing proficiency of students in special education colleges employing STT technology. Furthermore, covariate evaluation (ANCOVA) was methodically conducted to minimize the influence of potential confounding factors, therefore isolating the specific effects of the intervention being studied.

#### 4. Results

The following section presents the data obtained from the statistical analysis of the research instrument. **Table 1** presents the descriptive statistics for the pre-test.

**Table 1.** Descriptive statistics for pre-test scores.

Group	Mean Score	Standard Deviation
Experimental	55.3	8.2
Control	53.8	7.5

The average pre-test scores for the experimental (STT) and control groups were 55.3 and 53.8, respectively. The experimental group had a standard deviation of 8.2, whereas the control group had a standard deviation of 7.5. These descriptive data offer an initial summary of the participants' writing performance before the intervention, emphasizing a minor disparity in average scores between the two groups.

After the intervention, **Table 2** shows the average scores on the post-test for the experimental (STT) and control groups were 68.5 and 57.2, respectively. The experimental group had a standard deviation of 10.1, whereas the control group had a standard deviation of 8.7. The results indicate a significant rise in average scores for the experimental group, suggesting a potentially beneficial effect of the speech-to-text (STT) technology on the participants' writing abilities. **Table 3** presents the results for the pre-test scores.

**Table 2.** Descriptive statistics for post-test scores.

Group	Mean Score	Standard Deviation
Experimental	68.5	10.1
Control	57.2	8.7

**Table 3.** T-test results for pre-test scores.

Test	<i>t</i> -value	df	<i>p</i> -value
Experimental vs Control	1.25	298	0.212

The t-test, which examined the average pre-test scores of the experimental (STT) and control groups, resulted in a *t*-value of 1.25 with 298 degrees of freedom. The calculated *p*-value is 0.212. Since the *p*-value exceeds the standard significance level of 0.05, there is no statistically significant distinction in the average pre-test scores between the two groups before the intervention. In the **Table 4** below, the results for the post-test are presented.

**Table 4.** T-test results for post-test scores.

Test	<i>t</i> -value	df	<i>p</i> -value
Experimental vs Control	3.76	298	<0.001

The t-test, which compared the average post-test scores of the experimental (STT) and control groups, resulted in a *t*-value of 3.76 with 298 degrees of freedom. The *p*-value is less than 0.001, showing statistical significance. This indicates a notable disparity in the average post-test results between the two groups following the intervention. The presence of a positive *t*-value indicates that the experimental group, which made use of speech-to-text (STT) technology, had a statistically significant enhancement in writing abilities when compared to the control group. The correlation between the use of STT and writing skills is presented in **Table 5** below.

**Table 5.** Correlation analysis results between stt usage and writing skills improvement.

Variable	Correlation Coefficient	<i>p</i> -value
STT Usage and Writing Skills Improvement	0.45	<0.001

The correlation study demonstrated a statistically significant positive link between the utilization of speech-to-text (STT) technology and enhancements in writing abilities, as indicated by a correlation value of 0.45 ( $p < 0.001$ ). These findings suggest that when the frequency of speech-to-text (STT) usage rose, there was a concurrent improvement in the participants' writing abilities. The robustness of the link indicates a moderate connection between the utilization of speech-to-text technology and enhancements in writing skills. To find the effect of STT on writing skills, the regression analysis was used as shown in **Table 6**.

**Table 6.** Regression analysis results for factors affecting writing skills improvement.

Predictor Variable	Beta Coefficient	Standard Error	t-value	p-value
STT Usage Frequency	0.56	0.08	7.00	<0.001
Prior Writing Skills	0.28	0.12	2.33	0.021
Teacher Support	0.12	0.05	2.40	0.017

The regression study sought to investigate the predictive capacity of several parameters on the efficacy of speech-to-text (STT) technology in improving writing proficiency. The findings demonstrate that the frequency of STT usage (Beta = 0.56,  $p < 0.001$ ) is a strong predictor of development in writing skills. This suggests that when the frequency of STT usage increases, there is a considerable beneficial effect on the enhancement of writing abilities. Furthermore, the study found that Prior Writing Skills (Beta = 0.28,  $p = 0.021$ ) and Teacher Support (Beta = 0.12,  $p = 0.017$ ) were also shown to be significant predictors, although their beta coefficients were less.

In summary, our findings suggest that the frequency of STT usage is a crucial factor in predicting enhancements in writing abilities among the characteristics that were analyzed. The impact of previous writing abilities and instructor assistance, although statistically significant, is quite little in comparison. To find the differences in the grade level on the writing performance, the ANOVA analysis was used as presented in **Table 7**.

**Table 7.** ANOVA results for different grade levels on writing performance.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value
Between Groups (Grade Levels)	280.6	2	140.3	6.42	0.002
Within Groups (Residual)	540.8	147	3.68		

The ANOVA analysis sought to determine the influence of various grade levels on the writing proficiency of special education students utilizing speech-to-text (STT) technology. The F-value for the between-groups (grade levels) variance is 6.42, with a  $p$ -value of 0.002. This suggests that there is a statistically significant disparity in the average writing scores across various grade levels.

If the  $p$ -value is lower than the standard significance level, such as 0.05, it indicates that there is a significant difference in the mean writing scores between at least one of the grade levels. To determine the individual grade levels that exhibit significant differences, post-hoc tests such as Tukey’s HSD would be employed as shown in **Table 8**.

**Table 8.** ANCOVA results for writing performance controlling for prior writing skills.

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F-value	p-value
Covariate (Prior Writing Skills)	120.2	1	120.2	14.89	<0.001
Group (Experimental vs. Control)	220.6	1	220.6	27.38	<0.001
Residual	340.8	147	2.32	-	-

The ANCOVA analysis was conducted to examine the influence of speech-to-textual content (STT) technology on writing performance while accounting for the



potential confounding variable of prior writing skills. The covariate (Prior Writing Skills) had a significant effect, with an  $F$ -value of 14.89 and a  $p$ -value significantly less than 0.001. This suggests that differences in prior writing abilities significantly influenced the writing performance of participants.

In addition, the comparison between the experimental and control groups had a significant influence on the institution, as evidenced by an  $F$ -value of 27.38 with a  $p$ -value less than 0.001. This indicates that there is a significant difference in writing ability between the experimental (STT) and control groups, even after including the covariate of past writing abilities. This investigation focuses on the intricate relationship between speech-to-text (STT) technology and the writing aptitude of special education pupils in Saudi Arabia. It provides a thorough analysis within the framework of the educational system of the Kingdom. STT is an innovative and transformative technique that meets the unique needs of freshmen, as seen by the results. The ongoing arguments over the transformational capacity of assistive technology are supported by the works of Rose (2021) and Hong and You (2022). Supporting this idea, Baxter and Jack (2020) highlight the crucial role of assistive technology in meeting the diverse needs of individuals with impairments.

## **5. Discussion**

This study examines the intricate relationship between speech-to-text (STT) technology and the writing skills of special education pupils in Saudi Arabia. It offers a comprehensive analysis within the framework of the educational system of the Kingdom. The Speech-to-Text (STT) system is a dynamic and creative technology that effectively meets the diverse requirements of learners, as evidenced by the outcomes. This study provides evidence for the transformational potential of assistive technology, as demonstrated in the research conducted by Rose (2021), Hong and You (2022), and Thompson and Black (2024).

Students in special education have effectively improved their writing abilities with the use of Speech-to-Text (STT) technology. This tool is highly beneficial for tackling the specific challenges faced by children with impairments in the educational environment. Smith and Jones (2022) found that the use of assistive technology may greatly improve the skill acquisition of children with various learning needs. In addition, the studies conducted by Anderson and Reid (2023) and Johnson and Thompson (2024) emphasize the influence of Speech-to-Text (STT) technology on language comprehension and physical skills, presenting new possibilities for enhancing written communication.

An analysis of the study indicates that assistive technology, namely speech-to-text (STT), has a positive influence on pupils in special education. The present outcomes corroborate the conclusions of Kim et al. (2023), Baker and White (2022), and Lewis et al. (2024), emphasizing the revolutionary capacity of technology in conventional educational institutions. However, it is crucial to acknowledge the complexities of the Saudi Arabian setting that impact the results.

This research is in line with Saudi Arabia's Vision 2030, which is the educational goal set by the country in 2017. By using Speech-to-Text (STT) technology, we demonstrate our commitment to ensuring equal access to education. The findings of

this study can greatly contribute to the worldwide conversation on assistive technology and specific efforts to improve educational accessibility and quality, as outlined in the publications of Edwards and Patel (2020), Larson and Green (2021), and Williams and Clarke (2023).

By including t-tests, correlation, regression, ANOVA, and ANCOVA in the complete analysis, the depth and reliability of the results are enhanced. According to the study done by Hong and You (2022), there is a significant correlation between the use of speech-to-text technology (STT) and enhanced writing abilities. This finding supports the idea that consistent use of technology is connected to sustained competency over time. The regression analysis, supported by the research of Smith and Davis (2023) and Harper and Lee (2024), shows that the frequency of student talk time (STT) utilization has a notable effect, taking into account the nuanced effects of both prior writing experience and instructor assistance.

## **6. Conclusion**

The study encompasses a wide range of themes, nevertheless, some crucial factors need to be considered. While the quantitative study technique is comprehensive, it may overlook valuable qualitative information on the perspectives and opinions of special education students. Occasionally, standardized assessments fail to accurately capture the full spectrum of written expression. Furthermore, as the observer focuses on a specific demographic in Saudi Arabia, the findings may lack applicability outside the boundaries of that country. The outcomes of the examination indicate that educators and policymakers in Saudi Arabia should consider incorporating speech-to-text (STT) technology as a beneficial and efficient supplementary tool in special education. The significant increase in writing proficiency observed in special education students who utilized Speech-to-Text (STT) technology suggests that it has the potential to effectively overcome the challenges faced by this group, particularly in terms of improving fine motor skills and language comprehension impairments

## **7. Recommendations**

To maximize effectiveness, professional development programs must be intended to assist educators in improving their competency in utilizing and integrating speech-to-text technology into their teaching methods. Continuous engagement of technology professionals and specialized education experts is crucial to guarantee that the integration of speech-to-text generation is in line with the evolving needs of children. To provide equitable access to special education at all universities, legislators must also consider reallocating money for the procurement and maintenance of assistive devices. Future research can focus on providing an inclusive educational environment for special education children in Saudi Arabia by exploring various methodologies that use assistive technology. This will enable us to remain updated on the ever-changing circumstances and ensure that these children are receiving the highest level of support.

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