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Development of Comma 2.0 as an English learning application for early childhood using the Quality Function Deployment (QFD) method

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Abstract

Comma 2.0 is an English learning application for early childhood that is specifically created for TK Roudlotul Muttaqin Mojokerto. . The purpose of this research was to process user feedback regarding the comparison of the development of Comma 2.0 with the previous version by using the Quality Function Deployment method in order to provide more optimal development in accordance with the users' expectations. One of the methods proven to be effective in language learning was Total Physical Response (TPR), which emphasized learning English by using three important aspects: commands, speaking, and actions. The research employed an experimental design with 15 children aged 4–6 years as participants. Data were collected through structured observations and user feedback assisted by teachers and parents, and analyzed using the Quality Function Deployment (QFD). The analysis focused on five attributes: material comprehension, application usability, attractiveness of animated characters, clarity of sound and visuals, and ease of imitating animations and sounds. From the results of the research, it could be concluded that the Comma 2.0 application was easy to use, contained easy-to-understand materials, and featured attractive animated characters with clear images and sounds that were easy to imitate by the application users.

Keywords: *childhood; Comma 2.0; earning; QFD; TPR*

INTRODUCTION

The Comma 2.0 application represents a significant upgrade from its predecessor, Comma 1.0, which was originally developed as an English language learning tool specifically tailored for early childhood education. This application was conceived and refined with a clear educational focus: to enhance the English learning process for young learners, particularly those enrolled at TK Roudlotul Muttaqin, a kindergarten located in Mojokerto, East Java. The development of Comma 2.0 responds to the unique educational challenges faced during the COVID-19 pandemic, a period in which conventional classroom learning was severely disrupted, and many institutions were forced to rely on informal digital tools such as WhatsApp to maintain communication and deliver lessons. In this context, Comma 1.0 served as an

initial attempt to digitize English instruction. However, due to limitations in interactivity and pedagogical effectiveness, the need for a more engaging, structured, and user-oriented platform became evident, prompting the creation of Comma 2.0.

Although Comma 2.0 is currently available for download via the Google Play Store, its accessibility remains restricted to a closed group of partner institutions and users. This limitation ensures that its use can be monitored, and feedback can be gathered more effectively from a controlled sample of learners and educators. The ultimate goal is to refine the application based on user experience before considering broader deployment.

A key pedagogical foundation underlying Comma 2.0 is the Total Physical Response (TPR) method, which has long been recognized as an effective strategy in second language acquisition, especially for early childhood learners. TPR emphasizes the use of physical movement in response to verbal commands, which helps reinforce language comprehension through kinesthetic learning. It is particularly suitable for young children who tend to absorb information better through multisensory experiences. TPR incorporates three fundamental elements in language learning: commands (instructional listening), verbal speaking, and physical actions, creating an immersive and dynamic learning environment. By integrating this method into the Comma 2.0 platform—along with engaging visual animations, sound effects, and intuitive navigation—the application aims to promote a more holistic and enjoyable approach to learning English.

The main objective of this study is to assess and analyze user perceptions and feedback in comparing Comma 2.0 with Comma 1.0. This evaluation seeks to determine how well the upgraded version addresses previous shortcomings and meets users' current expectations. To achieve this, the study employs the Quality Function Deployment (QFD) methodology, a structured approach widely used in product development and service design. QFD enables developers to systematically capture the "voice of the customer" and translate these qualitative insights into technical specifications and improvement priorities. In this context, QFD serves not only as a tool for analysis but also as a framework for guiding the iterative development of the application to better align with both pedagogical goals and user experience requirements. Through this approach, Comma 2.0 is expected to continue evolving as a responsive and effective educational technology tool for early childhood English education.

Comma 2.0

The Comma application is an Android-based software designed for early childhood English learning. It is specifically developed for use by partner institutions, namely TK Roudlotul Muttaqin, located in Mojokerto. This approach is applied to develop specific English language skills in young learners, including listening comprehension through commands, speaking ability through verbal responses, and basic vocabulary acquisition reinforced by physical actions (Hayati et al., 2022). The application uses the Total Physical Response (TPR) method as the foundation for the development of Comma 2.0. TPR is one of the methods proven to be effective in language learning. This method emphasizes the use of physical movements as a way to understand and

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respond to the language being learned. (Suryantini, dkk 2021). The TPR method is a language learning approach that focuses primarily on English language acquisition by utilizing three key aspects: commands, speaking, and actions (Ni Luh et al., 2019).

The name of the Comma application is derived from the three aspects of TPR (command, speak, action). Children tend to be more responsive to learning that involves physical movement because it aligns with their active and multisensory learning styles (Hariyani, 2019). Educational applications enable the use of engaging technologies such as multimedia, animation, and interactive features that support more meaningful learning experiences (Akhiruddin et al., 2024; Ariani, 2019). The Comma application framework, or Learning Application Design (LAD), consists of three elements: input, process, and output. These elements aim to help users achieve the goals of English learning through the Comma application. However, in the continuous effort to improve the quality of education, developers keep seeking ways to optimize the learning experience through technology.

The advancement of digital technology has driven a major transformation in the field of education, including in early childhood English language learning. In this context, the use of mobile applications such as *Comma 2.0* represents an innovation well-suited to the characteristics of young children, who tend to be kinesthetic and visual learners. Technology-based interactive learning has been proven to enhance learning motivation and strengthen children's memory retention of the material being studied (Ali et al., 2025). This application, which adopts the Total Physical Response (TPR) approach and incorporates multimedia features such as animations, audio, and conversational activities, offers a holistic and multisensory learning experience. The TPR-based learning model itself has been extensively researched and shown to be effective in helping children acquire new vocabulary and understand sentence structures through physical activities and direct instructions (Fadlan et al., 2021). Young children tend to learn through exploration and play, and when digital technology is combined with communicative and thematic approaches as found in *Comma 2.0*, the learning process becomes more enjoyable and effective (Nurjanah & Mukarromah, 2021). Active engagement in learning through digital media has even been linked to improved early literacy development, including pronunciation, comprehension, and verbal responsiveness (Kaptiningrum, 2025). Therefore, *Comma 2.0* is not merely a language introduction application, but also a pedagogical tool designed to meet the developmental needs of early childhood learners in the digital age.

In response to this need, the Comma application has undergone significant changes, evolving into Comma 2.0. This transformation reflects a commitment to enhancing the features, functionality, and effectiveness of English learning for early childhood. Comma 2.0 introduces a new feature called conversations, accompanied by added animations using images and sounds, with the hope that users can more easily understand the lessons and engage in enjoyable learning activities. English learning can be done through reading; however, reading alone is not sufficient. It requires learning while engaging in

conversations, also known as learning by conversation (Diarta et al., 2023; Iswindarti et al., 2021).

Quality Function Deployment

One method that can be used to design and develop an application to meet the needs and desires of customers is the Quality Function Deployment (QFD) method ((Nurochim & Rukmana, 2021). Quality Function Deployment (QFD) is a product development concept aimed at enhancing design quality to satisfy customers. It translates customer demands into design targets and key quality assurance points to be used throughout all stages of production (Atha & Mochamad Tutuk Safirin, 2022). There are three main benefits a company can gain by using the Quality Function Deployment (QFD) method: reducing costs, increasing revenue, and shortening production time (Utami, 2018). The use of the Quality Function Deployment (QFD) methodology in the product design and development process provides added value for a company, as it enables the company to gain a competitive advantage by creating products or services that satisfy customers (Prabowo & Zoelangga, 2019).

Recent studies show that the implementation of Quality Function Deployment (QFD) not only enhances product design efficiency but also significantly contributes to cost optimization and improved product performance. For instance, in a study involving the application of QFD in a small food enterprise (risoles MSME) in Batam, it was found that identifying customer needs such as taste, packaging, and hygiene could be translated into technical characteristics that minimized product defects while increasing customer satisfaction (Listyalova & Lawi, 2024). The integration of QFD with lean manufacturing methodologies has also proven effective in reducing waste in production processes, as demonstrated in a manufacturing case at Universitas Brawijaya, where the prioritization hierarchy of the House of Quality (HoQ) helped clarify process improvement focus and eliminate production inefficiencies (Mubarok & Sasongko, 2023). Moreover, in the context of agribusiness, the application of QFD in the design of local products such as *tempoyak* (fermented durian) and domestic melon varieties successfully identified key consumer attributes and mapped relevant technical parameters within the HoQ framework to support local product development (Hardiyanti et al., 2022). These three cases demonstrate that QFD effectively aligns customer needs (voice of the customer) with technical targets (voice of the engineer), resulting in more accurate product designs, reduced design errors, shorter production times, and improved cost efficiency and product competitiveness.

In general, Quality Function Deployment (QFD) can be described as a product development system that starts from the product design process, continues through manufacturing, and ends with the product being delivered to customers according to their desires (Rasyid Ibrahim Arsy et al., 2023). Quality Function Deployment (QFD) is also a practice aimed at process improvement that enables organizations to exceed their customers' expectations. The main stages that must be implemented in applying the QFD method include quality assurance of products and services, customer evaluation of products and services, creating customer needs questionnaires, conducting customer surveys, preparing checklists, and developing the House of Quality matrix (Olga & Rudihartati, 2020).

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Quality Function Deployment (QFD) consists of the following activities: (1).Elaboration of customer requirements (quality needs); (2). Elaboration of measurable quality characteristics; (3). Determination of the relationship between quality requirements and characteristics. 4. Assignment of values based on specific numbers to each quality characteristic; (5). Integration of quality characteristics into the product; (6). Design, production, and quality control of the product (Rahman & Supomo, 2016).

The tool used to implement the Quality Function Deployment (QFD) structure is a matrix shaped like a house, called the House of Quality (HOQ). The House of Quality (HOQ) serves as a framework or structure and is an instrument used to apply the QFD methodology (Alfatiyah, 2018). The HOQ is a collection of matrices containing customer desires (voice of the customer), all derived from the processing of questionnaires. The House of Quality (HOQ) is essential for delivering quality capacity by using measurement arrangements to connect client needs with how the organization fulfills those needs. The HOQ is used to translate customer requirements, market research results, and benchmarking data into a set of prioritized technical targets (Haris Adieba et al., 2016). Through this process, the use of QFD directly influences the design and effectiveness of Comma 2.0 by ensuring that application features—such as ease of use, clarity of sound and visuals, and attractiveness of animations—are aligned with user expectations. Consequently, the method helps minimize design errors, improve user satisfaction, and enhance the overall learning effectiveness of the application for early childhood learners.

In addition to the basic aspect of the House of Quality (HoQ) matrix that links the voice of the customer with technical requirements, the matrix also includes a roof, which represents the correlation matrix among technical parameters. This roof illustrates how one technical characteristic may support or conflict with another—indicated by symbols such as "++" for strong positive correlations and "--" for negative ones (Rathomi et al., 2020). The relationship between customer requirement attributes and technical parameters in the House of Quality (HoQ) matrix is further enriched through the use of a numerical weighting scale—typically assigning the value of 9 to indicate a strong relationship, 3 for a moderate relationship, and 1 for a weak relationship. The purpose of this scale is to provide a quantitative representation of the extent to which each technical parameter influences user satisfaction. This allows the development team to systematically assess the contribution of each technical element to the previously identified customer needs. Such quantification enables the calculation of total scores and the execution of priority analysis, thereby supporting strategic decision-making in feature development that is more objective, measurable, and focused on the most critical needs from the perspective of the end user (Abdi & Chalimah, 2020; Hidayat & Negoro, 2023). Furthermore, the creation of the House of Quality (HoQ) does not stop at mapping the relationship between the voice of the customer and technical requirements, but also incorporates competitor benchmarking. This involves evaluating the performance of competing products, enabling users to map their own product's position and set improvement targets accordingly. The final outcome is a set of clear and measurable technical target values ("How Much?")

for each design aspect, determined based on customer needs, competitive positioning, and technical priorities (Isrofah et al., 2022; Kesuma & Amelia, 2022).

The House of Quality (HOQ), a relationship matrix is obtained that shows the connections between the properties within it. There are also indicators of the strength of these relationships, which are usually represented by several visual symbols. A filled circle (●) indicates a very strong relationship, while an empty circle (○) represents a moderate relationship. A triangle (Δ) shows a weak relationship, and a blank space indicates that no relationship exists between the attributes (Firmansyah et al., 2021).

Prior research has consistently shown that TPR is effective in supporting vocabulary acquisition and comprehension through physical movement, while other studies have demonstrated that multimedia-based applications increase children's engagement and motivation (Hounhanou, 2020). However, most existing works focus either on conventional classroom implementation of TPR or on general digital learning tools without a systematic approach to aligning user needs with application design (Purwa et al., 2021). This limitation highlights the gap addressed in the present study, which integrates TPR into a specifically designed Android-based application and evaluates its effectiveness using the Quality Function Deployment (QFD) method. By combining pedagogical strategies with structured product development analysis, this research offers a distinct contribution to the literature, ensuring that Comma 2.0 is not only educationally sound but also responsive to the expectations and needs of its young users.

METHOD

This study adopts an experimental approach as its research design, aiming to observe the effects and perceptions of using the Comma 2.0 application among early childhood learners. The research sample comprises 15 children aged between 4 to 6 years from TK Roudlotul Muttaqin in Mojokerto, who were selected based on their active participation in learning activities and parental consent. All participants were placed in a single experimental group, which underwent a two-phase learning experience. In the first phase, the children received conventional English instruction, typically delivered through basic classroom interactions or distance learning tools such as WhatsApp. In the second phase, the same group of children was introduced to English learning using the Comma 2.0 application, which integrates the Total Physical Response (TPR) method as its pedagogical foundation.

The TPR method employed in the application emphasizes the incorporation of physical movements such as gestures, commands, and actions as a means for children to process and internalize new language concepts. This method is especially suitable for early childhood learners, as it aligns with their natural learning tendencies which are heavily reliant on motor activity, imitation, and auditory-visual stimuli (Purwa et al., 2021). The use of TPR through a digital platform such as Comma 2.0 also provides a unique opportunity to blend traditional language learning strategies with modern educational technology, potentially increasing engagement and retention.

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After the completion of the learning sessions, the children, with the help of their teachers and guardians, responded to a structured survey instrument designed to assess their experience. The survey focused on measuring the children's perceptions regarding various elements of the learning process, including their comfort and interest in using the application, the effectiveness of the TPR method in helping them understand the material, and their overall enjoyment during the learning activity. Although the survey was directed at young learners, the responses were interpreted through observation, assisted feedback from adults, and simple response scales appropriate to the children's developmental level.

The collected data was subsequently analyzed using the Quality Function Deployment (QFD) method, a structured approach used to transform qualitative user needs into quantitative parameters for product development. Specifically, the study involved comparing the current version of the application (Comma 2.0) with its previous version (Comma 1.0), in order to map user feedback into a set of prioritized design improvements. The analysis focused on five primary variables, which served as the basis for constructing the House of Quality (HoQ) matrix: (1) ease of understanding the instructional material, (2) ease of application usage, (3) attractiveness of animated characters, (4) clarity of sound and images, and (5) ease of imitating the animation movements and sounds. These attributes reflect key dimensions of both pedagogical effectiveness and user experience, forming the foundation for evaluating the application's quality and guiding its future enhancement.

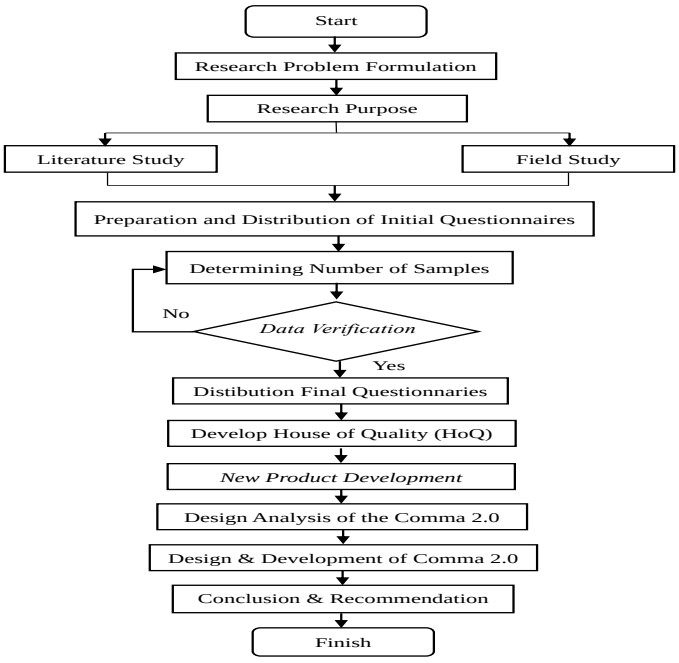

Figure 1. Research Process Flowchart

RESULTS AND DISCUSSION

To evaluate the quality of this application, an analysis was conducted based on customer statements that reflect their experience in using the application. This

analysis focuses on five main aspects: ease of understanding the material, ease of using the application, attractiveness of the animated characters, clarity of sound and visuals, and ease of imitating animation movements and sounds. By understanding user needs across these aspects, it can be concluded that the Comma 2.0 application offers several advantages that support interactive learning.

Table 1. Interpretation of Customer Statement

No	Question	Customer Statement	Interpreted Needed
1	Easy to Understand Material	Users can easily operate the Comma 2.0 application, which supports the learning process..	The material in the Comma 2.0 application is easy to understand, aligning with user expectations.
2	Easy to Use Application	Users can easily operate the Comma 2.0 application, which supports the learning process	The Comma 2.0 application is user-friendly and meets user expectations.
3	Appealing Animated Characters	Users find the learning process more interactive because the animated characters in Comma 2.0 are appealing.	The animated characters in the Comma 2.0 application are attractive and meet user preferences.
4	Clear Sound and Visuals	The sound and visuals in Comma 2.0 are clear, allowing users to receive the learning content better.	The sound and visuals in the Comma 2.0 application are clear and fulfill user expectations.
5	Easy to Imitate Animation & Sounds	The animated movements and sounds in Comma 2.0 are easy to imitate, making learning easier for users	The movements and sounds in Comma 2.0 animations are easy to imitate, as expected by users.

By collecting feedback from 15 respondents who are users of the application, the following is the result of the Likert scale table based on the level of importance (Alfatiyah, 2018):
1 = Not important
2 = Slightly important
3 = Neutral
4 = Important
5 = Very Important

Table 2. Results of Grouping into Primary Hierarchy Based on Likert Scale

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Variable	Scale					Mean	%	N	Rank
	1	2	3	4	5				
Easy to Understand Material			2	5	8	4,4	20,95	15	I
Easy to Use Application		1	3	2	9	4,267	20,32	15	II
Appealing Animated Characters		1	1	5	8	4,333	20,63	15	III
Clear Sound and Visuals		2	2	4	7	4,067	19,37	15	IV
Easy to Imitate Animation & Sounds		3	2	3	7	3,933	18,73	15	V

3.1 Arranging Product Attributes Based on Priority

Product attributes are elements of a product that are considered important by consumers and serve as the basis for making purchasing decisions (Rathomi et al., 2020). The following are the product attributes for the development of the Comma 2.0 application:

Table 3. Product Attributes

No	Product Atrributes	*Relative Importance Index* (*Weights Factor*)
1	Easy to Understand Material	5
2	Easy to Use Application	4
3	Appealing Animated Characters	5
4	Clear Sound and Visuals	5
5	Easy to Imitate Animation & Sounds	4

3.2 Evaluating the Product to Be Developed and Comparing It with the Previous Version

Benchmarking is a strategic and systematic process that involves measuring, analyzing, and comparing the features, performance, and outcomes of a current product with those of a previous version or with comparable alternatives, with the primary goal of identifying both strengths to be maintained and weaknesses to be addressed (Rathomi et al., 2020). In the context of this research, benchmarking plays a critical role in evaluating the progress made from Comma 1.0 to Comma 2.0 by highlighting specific areas of improvement as well as aspects that may still require refinement. This process provides valuable insights into how the new version of the application performs in terms of usability, effectiveness, and user satisfaction when compared to its earlier iteration. The following section presents a detailed performance evaluation of the Comma 2.0 application in direct comparison to Comma 1.0, focusing on core product attributes such as ease of use, clarity of sound and visuals, appeal of animated characters, comprehensibility of material, and the ability to imitate animations and sounds—all of which are crucial for achieving the intended learning outcomes in early childhood English education:

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Table 4. Evaluating the Product

Product Atrributes	1 2 3 4 5
Easy to Understand Material	
Easy to Use Application	
Appealing Animated Characters	
Clear Sound and Visuals	
Easy to Imitate Animation & Sounds	

Comma 1.0 *Comma 2.0*

3.3 Defining Product Design Modification

By carefully analyzing and considering the comparison of performance data between Comma 1.0 and Comma 2.0, along with a thorough examination of the relative importance index (weight factor) derived from user evaluations, and the identification of key product attributes deemed essential by users, it becomes possible to systematically recognize specific areas within the application that require further enhancement (Rathomi et al., 2020). These identified areas not only reflect technical aspects of the application's design but also embody users' functional and emotional needs. Consequently, this comprehensive analysis serves as a critical foundation for formulating clear and measurable improvement objectives, which will guide the next phase of development in the application design modification project. These objectives, also referred to as product development goals, are intended to align with both educational effectiveness and user satisfaction, ensuring that future iterations of the application can deliver an even more refined and impactful learning experience for early childhood users.

Table 5. *Project objectives*

Product Atributes	1 2 3 4 5	***Target Value***	***Improvement Rate***	***Rel. Imp. Index***	***Weight***	***Weight (%)***
Easy to Understand Material		4	0,8	5	4	20
Easy to Use Application		3	0,75	4	3	15
Appealing Animated Characters		5	1	5	5	25
Clear Sound and Visuals		4	0,8	5	4	20
Easy to Imitate Animation & Sounds		4	1	4	4	20
					20	100

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3.4 Determining Technical Parameters and Relationships Between Parameters

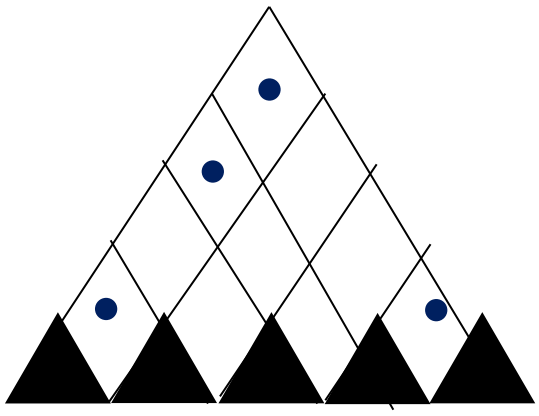
Table 6. *Interaction metric*

= ***Strong Relationship*** **(9)**
= ***Medium Relationship*** **(3)**
= ***Weak Relationship*** **(1)**

Product Attributes	Interesting Material	Class Feature	Small Memory Used	Colorful Interface	Sharp Display	***Rel.Imp.Index***
Easy to Understand Material	● 180	● 180				5
Easy to Use Application		▭ 45	● 135			4
Appealing Animated Characters	● 225					5
Clear Sound and Visuals	● 180			● 180	● 180	5
Easy to Imitate Animation & Sounds	● 180			● 180	● 180	4
SUM Scores	765	225	135	360	360	1845
Priority (%)	41.46	12.2	7.32	19.51	19.51	100%

3.5 House of Quality Designing

Table 7. *House of Quality*



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● = ***Strong Relationship*** **(9)**

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Product Attributes	Interesting Material	Class Feature	Small Memory Used	Colorful Interface	Sharp Display	Relative Important Index
Easy to Understand Material	● 180	● 180				5
Easy to Use Application		▭ 45	● 135			4
Appealing Animated Characters	● 225					5
Clear Sound and Visuals	● 180			● 180	● 180	5
Easy to Imitate Animation & Sounds	● 180			● 180	● 180	4
SUM *Scores*	765	225	135	360	360	1845
Priority (%)	41.46	12.2	7.32	19.51	19.51	100%
Measurement Unit	-	-	-	-	-	
Our Product	a	c	e	g	x	
Competitive Product	b	d	f	h	y	
Target Value	b	d	f	h	y	

These findings align with previous studies that emphasize the role of multimedia and animation in enhancing young children's engagement and comprehension in language learning. According to (Ariani, 2019), the use of visual and auditory features in educational multimedia significantly improves children's focus and understanding, particularly in early childhood settings. Similarly, research by (Ali et al., 2025) demonstrates that interactive learning applications, when integrated with child-friendly interfaces and engaging content, can increase both motivation and vocabulary retention. This supports the observation that users of Comma 2.0 perceive animated characters and sound clarity as essential attributes. Moreover, the presence of Total Physical Response (TPR)-based features, which emphasize physical interaction and command-based learning, echoes findings by (Ni Luh et al., 2019)who noted that children better acquire new language structures through movement-based instructional models.

The results of this study show that Comma 2.0 has met user expectations in several key areas, namely the ease of understanding materials, user-friendly application design, attractiveness of animated characters, clarity of sound and visuals, and ease of imitating movements and sounds. Compared to Comma 1.0, the new version provides clearer multimedia features, more interactive content, and improved usability, which collectively enhance the learning experience. The comparison highlights that while Comma 1.0 was limited in interactivity and engagement, Comma 2.0 successfully integrates TPR-based learning with engaging animations and audio-visual support, making the application more effective for early childhood learners. The emphasis should be placed on the fact

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that children responded enthusiastically to the interactive elements, particularly animations and sound clarity, which directly supported vocabulary acquisition and speaking practice. These findings indicate that the most critical improvement of Comma 2.0 lies in its ability to sustain attention and motivate young learners, thereby ensuring that the application not only functions as a digital tool but also as a meaningful learning medium.

CONCLUSION

The development of the Comma 2.0 application as an English learning medium for early childhood education represents a significant innovation in integrating technology with pedagogical approaches tailored to the characteristics of young learners. Through this structured methodology, the research successfully identified and translated user expectations into technical development priorities that reflect both educational value and usability aspects. Comma 2.0 was designed specifically to meet the needs of children aged 4–6 years at TK Roudlotul Muttaqin in Mojokerto. The application's foundation rests on the Total Physical Response (TPR) method, which has been shown to be particularly effective for language acquisition among young learners. TPR emphasizes learning through physical activities combining commands, verbal responses, and physical movements to create a multisensory experience that aligns with how children naturally acquire language. The integration of TPR into Comma 2.0 allowed for a learning experience that was not only educational but also interactive and enjoyable, thereby increasing motivation and retention. The findings of this study, which were derived from user surveys and the QFD matrix, indicate that Comma 2.0 has met or exceeded expectations in several key areas. These include the ease of understanding the learning materials, the intuitive and user-friendly design of the application, the attractiveness of the animated characters, the clarity of both sound and visual elements, and the ease with which children can imitate animations and spoken phrases. These five dimensions were consistently rated as important by users and received high scores in the Likert-based evaluation. The prioritization matrix of the House of Quality further supported these results by identifying them as critical quality attributes requiring focus in the development process. The comparative analysis between Comma 1.0 and Comma 2.0 also revealed a clear trajectory of improvement. In particular, the second version addressed several limitations of the earlier iteration, such as limited interactivity, less engaging visuals, and lack of conversational features. By incorporating these enhancements, Comma 2.0 positioned itself not merely as an upgrade but as a comprehensive reimagining of how technology can be used to support early language education. From a technical perspective, the analysis also highlighted several internal development aspects that directly contributed to the application's perceived quality. Attributes such as minimal memory usage, a colorful and engaging interface, and a sharp display resolution proved essential in ensuring accessibility across various Android devices while maintaining performance. These elements, although often overlooked in purely educational discussions, play a critical role in ensuring that the application remains practical and functional for its target users—young children in diverse socio-economic settings. However, the main challenges in developing such an application include designing age-appropriate content, maintaining children’s attention through engaging visuals and sounds,

ensuring ease of use for both learners and teachers, and balancing educational objectives with interactive features to avoid distraction. In summary, the Comma 2.0 application has successfully integrated pedagogical principles and user-centered design to deliver an English learning tool that is both effective and appealing for early childhood learners. The use of the QFD method enabled the development team to systematically align technical improvements with user expectations, resulting in a product that not only enhances learning outcomes but also delivers a positive user experience. The findings also show that early childhood learners respond enthusiastically to interactive digital learning tools like Comma 2.0. Children demonstrated higher engagement, enjoyment, and motivation when interacting with the application, particularly due to its use of animations, clear sound, and movement-based activities. These responses suggest that interactive digital tools can effectively sustain young learners' attention and encourage active participation in the learning process. Overall, the results affirm that educational technology, when developed with careful consideration of user needs and learning theories, can significantly improve the quality and accessibility of language education for young children

AUTHOR STATEMENTS

Kinanti R. Hayati contributed to the conceptualization of the study, designed the research framework, and supervised all stages of the project. **Heru P. Utomo** was responsible for methodology design, data validation, and critical review of the manuscript. **Radito Anggoro** contributed to the data analysis and interpretation, and provided input on the theoretical framework. **Tranggono** assisted in refining the research instruments and contributed to the discussion of findings. **Afita D. Prastiwi** conducted the literature review and was involved in editing and revising the manuscript. **Albertus A.S. Prakosa** participated in data collection and preliminary data processing under supervision. **Aldi P. Nugroho** was responsible for preparing the first draft of the manuscript and assisted in data visualization and formatting.

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