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Research Article

PRESERVING THE N'KO SCRIPT: AN ANIMATION-BASED COMPUTER-ASSISTED LANGUAGE LEARNING SYSTEM FOR YOUNG MANINKA LEARNERS

Tidanke Sysavane Amao[1]; O.A Odejobi[2]

[1]Lecturer, Federal University of Health Science place, Department of Information Technology and Health Informatics, University, Ila-Orangun, Nigeria
[2]Professor, Obafemi Awolowo University, Computing Science and Engineering, Ile-Ife, Nigeria

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ABSTRACT

Maninka is a low-resource language of the Manding group, spoken in Guinea and neighboring West African countries, with few digital learning resources for young children. Existing Computer-Assisted Language Learning (CALL) resources for Maninka rely mainly on text and audio, despite children aged 2–7 learning languages largely through observation, imitation and interactive play. This study developed an animation-based CALL system for teaching Maninka vocabulary, numerals, alphabet and grammar using N'ko and Latin orthographies.

The study adopted a prototyping software development methodology. Maninka linguistic data were collected through questionnaires, interviews and consultation with language experts. The sentence structure was formally represented using a Context-Free Grammar (CFG), and its production rules were transformed into interactive learning exercises. Culturally grounded animated characters, Malik and Malika, were designed, and the system was implemented as a cross-platform Flutter mobile application, with N'ko assets created using Adobe Animate. The system was evaluated against a native-speaking human tutor by parents/caregivers of 40 children aged 2–7 years (20 per condition) following a two-week instructional program, using a Mean Opinion Score (MOS) survey.

Results showed that the animation-based system achieved higher usability (95.5%) and engagement (90%) than the human tutor (79% and 79%, respectively). It was broadly comparable in educational value (89% vs. 91%) but recorded lower satisfaction (87.5% vs. 94%). The study demonstrates that animation-based CALL can provide effective early-childhood language learning while supporting the digitization and preservation of N'ko and providing a replicable approach for other low-resource African languages.

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1. Introduction

Maninka is a Manding language used by several million people in Guinea, Mali, Côte d'Ivoire and neighbouring countries that is conventionally written in the indigenous N'ko script and in Latin transliteration. In spite of this linguistic extension, Maninka is not widely represented in the digital language-learning environment: the few Computer-Assisted Language Learning (CALL) materials that are available are either text-based or audio-based (Diatrou, 2008). A significant constraint for the youngest potential users. Language acquisition for children ages two to seven is primarily through observation, imitation and interactive, multi-sensory experience, not static text or audio, and text- and audio-only systems have been found to be significantly less effective than visual, animation-based language instruction for this age group (Kittidachanupap et al., 2012; Kuhl, 2007). Thus, there is currently no digital educational tool that is based on the actual learning processes of young children who speak the Maninka language, which has direct consequences for the intergenerational transmission of the N'ko script.

This study aims to fill this gap by designing and creating an Animation-Based Computer-Assisted Maninka Language Learning System, specially designed for children. Images, audio and animation are all combined into a single interactive environment, allowing for the practice of alphabet recognition, vocabulary learning, number learning and basic sentence construction to be done through play instead of repetition of text or audio. The basic question that guided the design and evaluation of the system was whether a learning experience using an animation-based CALL system based on a formal model of the grammar of Maninka can be as good as, or better than, a learning experience provided by traditional human tutors for young children. The use of digital learning tools more generally is already known to facilitate continuous, learner-paced exposure and repetition, the two factors most critical to language acquisition (Ima & Jihad, 2024), but this is not yet the case for Maninka in a form that is appropriate for children, a contribution this study makes.

A major contribution of this study is the development of an animation-based system for teaching the Maninka language for children aged 2–7 years; (ii) the formal representation of the grammar of Maninka using Context-Free Grammar production rules and parse-trees, and the translation of the formal grammar into pedagogical exercises that can be implemented interactively; and (iii) the empirical evaluation of the system in comparison to traditional human tutoring, using a controlled and parent-reported Mean Opinion Score study.

2. Literature Review

2.1 CALL and Multimedia Learning for Children

One thing that has been consistently reported in the CALL literature is the enhancement of the quality and flexibility of language instruction through digital tools. Chaudhary and Devi (2019) and Algaddari (2021) both suggest that CALL provides more interactive and self-paced learning environments which facilitates better teaching of grammar and vocabulary than traditional classroom instruction, and Ima and Jihad (2024) claim that the use of CALL is associated with measurable improvements in the engagement, motivation and autonomy of learners. In terms of early childhood specifically, Firdaus and Prasetyo (2025) revealed that interactive multimedia animated video, game-based activity and visual resources have a

significant effect on the academic performance, motivation and independent learning of early childhood. Combined, these studies demonstrate the following two points pertinent to this work: 1) the advantages of CALL are well documented for language learning in general; and 2) the advantages of CALL are enhanced, not weakened, when the learners are young children and the content is not text but rather multimedia. This is a good reason for the animation-first design used here, instead of the text or audio-first design.

2.2 Animation-Based and Indigenous-Language Learning Systems

The second line of research focuses on animation in particular, and not on multimedia in general. Rahmadhani et al. (2025) also conclude that using animation as teaching media is effective for improving spelling skills and student motivation, while Behforouz and Al Ghaithi (2025) also find that using AI-generated animation is effective in improving vocabulary skills and students' motivation. These studies validate the effectiveness of animation as an instructional media but neither study focus on an indigenous language or low resource language. Olayiwola et al. (2024) have built an AV-based Yorùbá language learning system with cultural components to assist in acquisition and preservation, while similar efforts have been undertaken with the Igbo language (Uche, 2018). As a whole, this collection of papers indicates that it is possible to construct animation-based systems for African languages and that these systems can be beneficial for language preservation and language learning, but that until now, only a relatively small number of Nigerian languages have been addressed, while others, such as Maninka, have remained unaddressed.

2.3 Low-Resource Language Technology and Preservation Challenges

A third stream focuses on the structural factors that contribute to the abandonment of languages such as Maninka. The lack of digitised linguistic data, poor quality corpora, and a lack of technological infrastructure among low-resource languages can make the development of learning applications more expensive and more difficult and can cause the intergenerational transmission of the language to slowly disappear if it is not addressed. Mehta et al. (2020) describe one set of solutions to this problem, namely, the use of targeted digital interventions such as language resources, children's stories and mobile applications to assist in revitalisation efforts for Gondi, while Joshi et al. (2019) warn that the adoption and sustainability of language technology in low-resource communities must consider social as well as technical issues. These studies validate the possibility of meaningful technology to support the preservation of the language, but they also validate the necessity of deliberate, community-based design, which drove the choices made in this study to work with a native Kankan-dialect speaker, culturally resonant characters, and the N'ko script, not a generic transliteration.

2.4 The Maninka Gap

Combining these three strands reveals a particular gap that has not been explored yet. Thus, a computer-assisted or animation-based learning system has been developed for African languages such as Yorùbá (Olayiwola et al., 2024) and Igbo (Uche, 2018), proving the approach is feasible and effective for African languages. However, Maninka has no: only text- and audio-based materials are available (Diatrou, 2008), which are independently found to be

under-performing in comparison to instruction in the form of visual and animation (Kittidachanupap et al., 2012; Kuhl, 2007). There is no model of the Maninka language that captures its linguistic structure and grammatical rules and that is delivered through animation that is specifically targeted at children, and no direct engagement with the preservation of the N'ko script by a child-focused digital tool. This is the gap that the present study aims to fill and is the main rationale for the system, grammar model and evaluation presented in the rest of this paper.

3. Methodology

The study used the prototyping software development methodology in designing and developing the Animation Based Computer Assisted Maninka Language Learning System. The first user interface and system workflow was created in Figma, enabling the visualisation and iterative development of system components before actual implementation.

3.1 Data Collection

Since Maninka is a low-resource language, a wide variety of digital and manual sources were used. Many of the digital resources were retrieved from the internet, including the web-based Maninka dictionary Malidaba. For consistency and accuracy, the Kankan dialect of Maninka, used in Guinea, was selected for the study, as it was familiar to the researcher and could be written using the N'ko system. The learning content that was collected included the Maninka alphabet (figures 1), vocabulary items, numbers and basic expressions. To ensure the material was meaningful to young children, vocabulary entries were selected from concepts that were familiar to them, such as greetings, body parts, colours, fruits and vegetables (Figure 2). Numerals in the Maninka language were gathered and organised both in N’ko and in Latin script, to aid in number-learning activities (Figure 3).

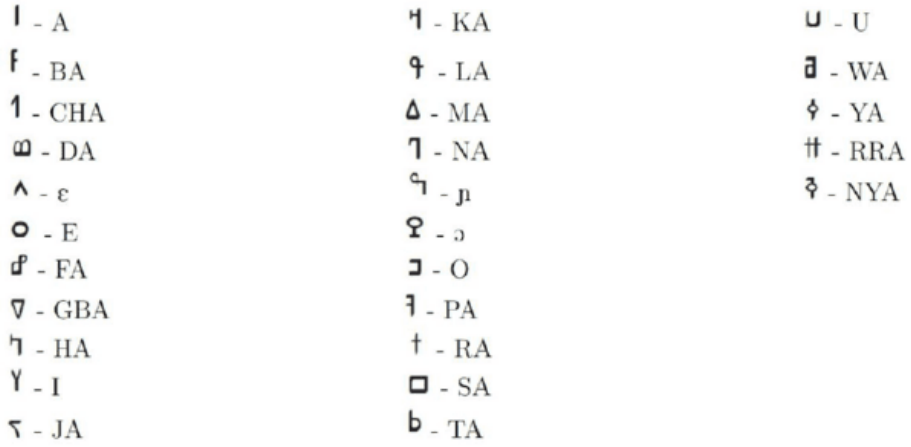


Figure 1: *Illustration of the Maninka Alphabet in N’ko and Latin Script*

English	Latin Script	N'ko	Direct English Translation
GREETINGS			
Good Morning (singular)	I ni sɔ́ɔma	ߊ ߒ ߜ ߏ ߡ ߬ ߊ	You and morning
Good Afternoon (singular)	I ni tele	ߊ ߒ ߕ ߍ ߇ ߊ	You and sun
Good Evening (singular)	I ni wúra	ߊ ߒ ߦ ߳ ߬ ߕ ߊ	You and evening
Good Morning (plural)	Álú ni sɔ́ɔma	ߊ ߇ ߣ ߒ ߜ ߏ ߡ ߬ ߊ	You all and morning
Good Afternoon (plural)	Álú ni tele	ߊ ߇ ߣ ߒ ߕ ߍ ߇ ߊ	You all and sun
Good Evening (plural)	Álú ni wúra	ߊ ߇ ߣ ߒ ߦ ߳ ߬ ߕ ߊ	You all and evening
BODY ORGAN			
Head	kùn	ߞ ߳ ߣ	None
Neck	kán	ߞ ߊ ߣ	None
Eye	ɲá	ߢ ߊ	None
Nose	nún	ߣ ߳ ߣ	None
Mouth	dá	ߘ ߊ	None
Ear	tɔ́lɔ	ߕ ߏ ߬ ߟ ߏ	None
Hand	bɔ́lɔ	ߓ ߏ ߬ ߟ ߏ	None
Finger	bɔ́lɔkoenɛn	ߓ ߏ ߬ ߟ ߏ ߞ ߏ ߋ ߛ ߋ ߣ	None
Chest	dísi	ߘ ߌ ߛ ߌ	None
Stomach	kɔ́nɔ	ߞ ߏ ߬ ߣ ߏ	None
Leg	sèn	ߛ ߋ ߣ	None
Toe	kòinɛn	ߞ ߏ ߬ ߌ ߣ ߋ ߣ	None
Back	kɔ́	ߞ ߏ ߬	None
COLOR			
Blue	bàndakololama	ߓ ߊ ߣ ߘ ߊ ߞ ߏ ߟ ߏ ߟ ߊ ߡ ߊ	Looks like sky
Red	wùlenman	ߡ ߍ ߟ ߋ ߣ ߡ ߊ ߣ	None
Green	fídakɛnɛlama	ߝ ߌ ߘ ߊ ߞ ߋ ߣ ߋ ߟ ߊ ߡ ߊ	Looks like Healthy green leaf
Orange	lèmununma	ߟ ߋ ߡ ߍ ߣ ߍ ߣ ߡ ߊ	None
Pink	bànankufadalama	ߓ ߊ ߣ ߊ ߣ ߞ ߍ ߝ ߊ ߘ ߊ ߟ ߊ ߡ ߊ	Looks like the branch of a cassava stem
Yellow	sáyi	ߛ ߊ ߬ ߌ	None
Black	fin	ߝ ߌ ߣ	None
White	gbɛman	ߜ ߓ ߋ ߡ ߊ ߣ	None
FRUITS AND VEGETABLES			
Banana	nàmasa	ߣ ߊ ߡ ߊ ߛ ߊ	None
Orange	lèmunun	ߟ ߋ ߡ ߍ ߣ ߍ ߣ	None
Mango	mánkòron	ߡ ߊ ߣ ߞ ߏ ߬ ߙ ߏ ߣ	None
Pineapple	jàbibi	ߖ ߊ ߓ ߌ ߓ ߌ	None
Avocado	piya	ߚ ߌ ߬ ߌ ߊ	None
Guava	bùyaki	ߓ ߍ ߬ ߌ ߊ ߞ ߌ	None
Coconut	kòko	ߞ ߏ ߬ ߞ ߏ	None

Figure 2: *Maninka Vocabulary, Organised by Everyday Semantic Category*

English Number	Maninka numbers in N'ko script	Maninka numbers in Latin script
0	߀	dòkolo
1	߁	kélen
2	߂	fila
3	߃	sàba
4	߄	náani
5	߅	lóolu
6	߆	wɔ́ɔrɔ
7	߇	wóronwùla
8	߈	ségin
9	߉	kɔ̀nɔndɔ
10	ߊ߀	tán
11	ߊ߁	tán ní kélen (10+1)
12	ߊ߂	tán ní fila
13	ߊ߃	tán ní sàba
14	ߊ߄	tán ní náani
15	ߊ߅	tán ní lóolu
16	ߊ߆	tán ní wɔ́ɔrɔ
17	ߊ߇	tán ní wóronwùla
18	ߊ߈	tán ní ségin
19	ߊ߉	tán ní kɔ̀nɔndɔ
20	ߋ߀	mùgan
30	ߋ߃	bi sàba
40	ߋ߄	bi náani
50	ߋ߅	bi lóolu
60	ߋ߆	bi wɔ́ɔrɔ
70	ߋ߇	bi wóronwùla
80	ߋ߈	bi ségin
90	ߋ߉	bi kɔ̀nɔndɔ
100	ߍ߀	kèmɛ

Figure 3: *The Maninka Numerals in N'ko and Latin Script*

Alphabetic, numerical and vocabulary resources were gathered and analysed, as well as the grammatical structures of Maninka nouns, verbs, determiners, adjectives and sentence-formation patterns for sentence-construction and grammar-learning activities. The linguistic resources were used as the basis for the formal grammar production rules described in Section 3.2.

3.2 Formal Representation of Maninka Grammar

One of the key elements of the proposed system is the formalization of the Maninka grammar for teaching. To model Maninka syntax for sentence construction and grammar learning, Context-Free Grammar (CFG) production rules were used which captured the relationship between noun phrases, verb phrases, nouns, verbs, adjectives, determiners and conjunctions.

Formally, a grammar for the Maninka language is denoted by the 4-tuple:

$$G_m ::= \langle N, \Sigma, S, P \rangle$$

where N is the set of non-terminal symbols; Σ is the set of terminal symbols; $S \subseteq N$ is the start symbol; and P is the set of production rules of the form $\alpha \rightarrow \beta$.

The base grammar used in this study is defined as follows:

1. N = {NounPhrase, VerbPhrase, Noun, Verb, Det, I}
2. Σ = { aisha, san, ka, muso, saki }

3. S = Sentence
4. P: ⟨Sentence⟩ → ⟨NounPhrase⟩⟨I⟩⟨VerbPhrase⟩

   ⟨NounPhrase⟩ → ⟨Noun⟩ | ⟨Det⟩⟨NounPhrase⟩

   ⟨VerbPhrase⟩ → ⟨Verb⟩ | ⟨NounPhrase⟩⟨Verb⟩

   ⟨I⟩ → { ka }

   ⟨Noun⟩ → { muso, saki }

   ⟨Verb⟩ → { san }

Figure 4 depicts the corresponding Maninka grammar parse tree, generated in JFLAP, which visualises how the production rules above combine to derive a valid Maninka sentence.

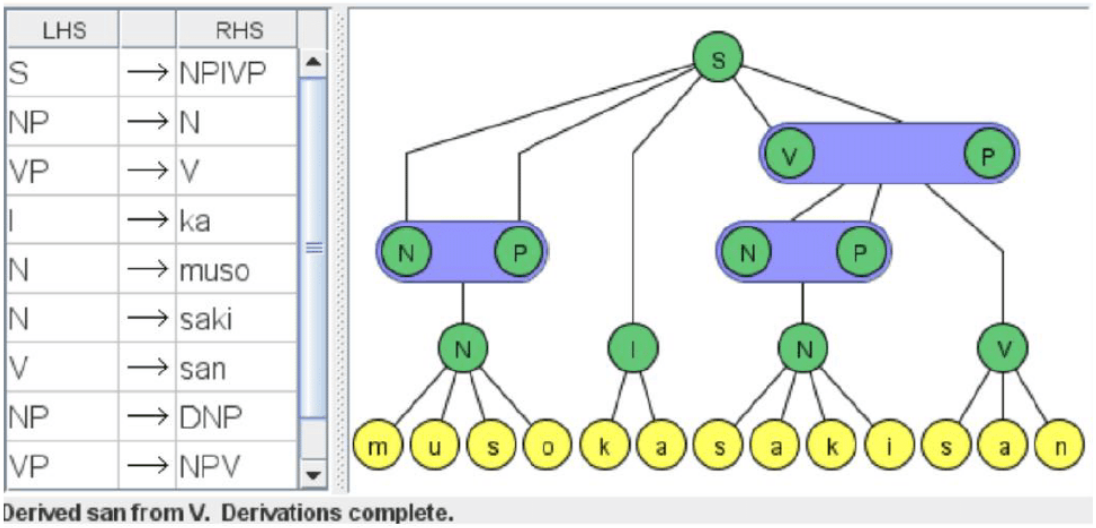


Figure 4: *Maninka Grammar Parse Tree, Generated in JFLAP from the Stated Production Rules*

The grammar was subsequently generalised beyond the base rule set to cover adjectival modification and conjunction. Let D = {S, NP, VP, AdjP, N, I, V, Det, Adj}, with P comprising lists of nouns, verbs, determiners and adjectives, and S = S as the start symbol. The generalised production rules are:

S → ⟨NP⟩⟨I⟩⟨VP⟩

S → ⟨S⟩⟨Conj⟩⟨S⟩

NP → ⟨N⟩ | ⟨Det⟩⟨N⟩

NP → ⟨NP⟩⟨AdjP⟩

NP → ⟨NP⟩⟨Conj⟩⟨NP⟩

VP → ⟨V⟩ | ⟨NP⟩⟨V⟩

VP → ⟨VP⟩⟨Conj⟩⟨VP⟩

AdjP → ⟨N⟩⟨AdjP⟩

where S, NP, VP, AdjP, N, V, Det, Adj and Conj denote Sentence, Noun Phrase, Verb Phrase, Adjectival Phrase, Noun, Verb, Determiner, Adjective and Conjunction respectively.

3.3 From Grammar to Pedagogy: Translating Production Rules into Learning Exercises

Pedagogical value of formal grammar can only be achieved if it can be made tangible to a young learner, thus, each production rule was explicitly mapped onto an interactive exercise template, instead of being left as an internal specification. In particular, an NP → NP Numerals production was realized as a drag and tap activity in which a child has to place a noun tile and a numeral tile together to form a phrase, for instance, Namasa kelen (one banana), as in Figure 8.

Likewise, the Det + Noun expansion of ⟨NounPhrase⟩ was represented as a matching task involving matching an icon of a determiner with an icon of a noun phrase, and the ⟨NounPhrase⟩⟨I⟩⟨VerbPhrase⟩ rule underlying the base sentence pattern was represented as a sentence-building task involving the sequence of animation cues (noun-phrase, ka, verb-phrase) for the character. This rule-to-exercise mapping ensured that each interactive task in the system was associated with a specific, language-based production rule, and not with any random content choice, so that a child's movement through the exercises was mapped to a movement through the underlying grammar.

3.4 System Development

The instructional characters were designed to be culturally appropriate to the target users to make them more relatable and engaging to learners. The characters, Malik and Malika, were adapted as young African children wearing traditional attire that is familiar in the learners' environment. Initial sketches were drawn on a graphics tablet and stylus pen and then digitised in Adobe Photoshop and Adobe Illustrator (Figure 5).

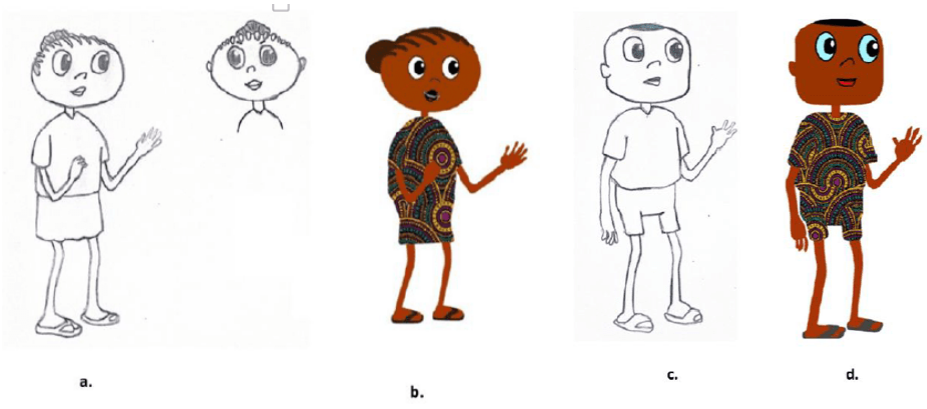


Figure 5: *Creation of the Animated Characters, Malik and Malika Initial Sketch (left) and Digitised Character (right)*

The characters of the N'ko alphabet used in the system were also created manually with a graphics tablet and stylus pen. Colourful elements and those that are suitable for children were used to enhance attention, recognition and memorisation for young learners. The chart for the developed Maninka alphabet is shown in Figure 6, which includes N'ko characters, transliterations of familiar objects in Latin script, and pictorial representations. For accurate acquisition, the audio material was recorded by a native Maninka speaker who is fluent with

the Kankan variety of the language, including alphabet pronunciation, vocabulary and number pronunciation. The visual, audio and grammatical elements were then combined into a single interactive learning environment (Figure 7), which can be used for alphabet recognition, vocabulary learning, learning numbers and sentence building activities, and designed as a cross-platform mobile application in the Dart programming language and the Flutter framework.

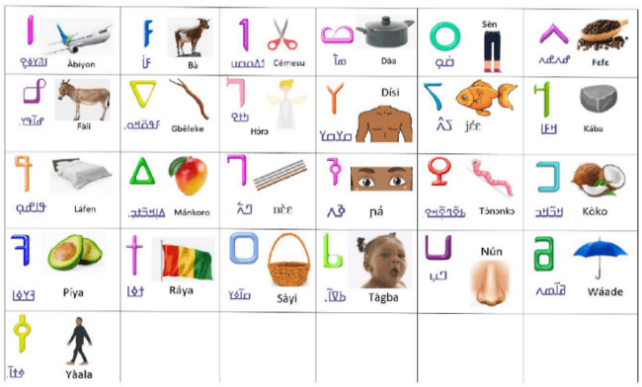


Figure 6: *The Maninka Alphabet Chart, Combining N'ko Script, Latin Transliteration and Pictorial Cues*



Figure 7: *The Developed Animation-Based Maninka Language Learning System*

The developed interface is suitable for instruction and assessment. In the assessment component, learners are given simple language activities that review concepts presented in the previous lessons. The exercise interface is shown in figure 8, where the production rule NP → NP Numerals (section 3.3) is used in creating the phrase Namasa kelen ("one banana").



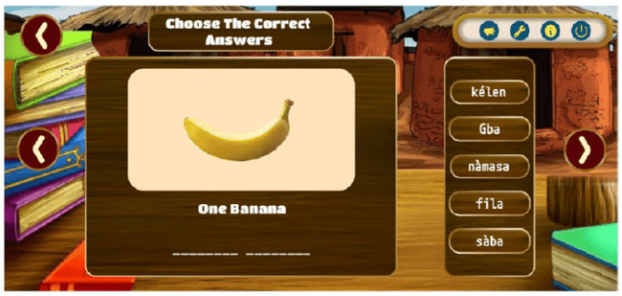


Figure 8: *Exercise Interface Applying the Production Rule NP → NP Numerals to Construct "Namasa kelen" ("One Banana")*

3.5 Evaluation Design

The system developed was tested to check its effectiveness as a language-learning system for young children. The four criteria were evaluated: usability, engagement, educational value and overall satisfaction, evaluated by the Mean Opinion Score (MOS) approach to compare the system with a native-speaker human tutor. Forty (40) learners aged between 2-7 years participated from playgroup to Basic One classes in a local school. The participants were split into two groups of 20, one group (Group A) using the developed system and the other group (Group B) being tutored by the man who speaks Maninka as his native language. The same instructional content was used for both groups in a 2-week programme. Parents/caregivers were asked to fill out a structured questionnaire at the end of the programme assessing their child's experience on each of the four criteria on a 5-point scale (1 = Very Poor, 5 = Excellent).

3.6 Limitations of the Methodological Approach

At the very beginning of this study, two methodological limitations are recognized, and they are directly related to the interpretation of the results of this study presented in Section 4. First, the age range of the participants (2-7 years) covers developmentally different language and motor development levels; a two-year-old and a seven-year-old are quite different in their attention span, fine-motor skill and language experience, and the fact that they were pooled in a single group of 20 children could have obscured differences between the sub-groups that would have been evident in a narrower or stratified age band. Secondly, learning outcomes were assessed indirectly via parent/carer questionnaires, not directly by the children themselves.

While parent-reported MOS is a reliable and practical proxy for young children who are not able to self-report, it is also a subjective measure that can be distorted by expectation effects, novelty bias, and parent disposition towards digital tools, and it is not objective evidence of language-acquisition gains (e.g., vocabulary recall, pronunciation accuracy). These restrictions do not affect the results of the study, but they limit the conclusions that can be made about the causal inferences that can be drawn from the results; these are discussed again in Section 5.3.

4. Results And Discussion

The comparative MOS performance of the Animation-Based Computer-Assisted Maninka Language Learning System and the human tutor on the four evaluation criteria is shown in

figure 9. The developed system was rated higher than the human tutor in terms of usability (95.5% vs. 79%) and engagement (90% vs. 79%) and marginally lower in terms of educational value (89% vs. 91%) and overall satisfaction (87.5% vs. 94%).

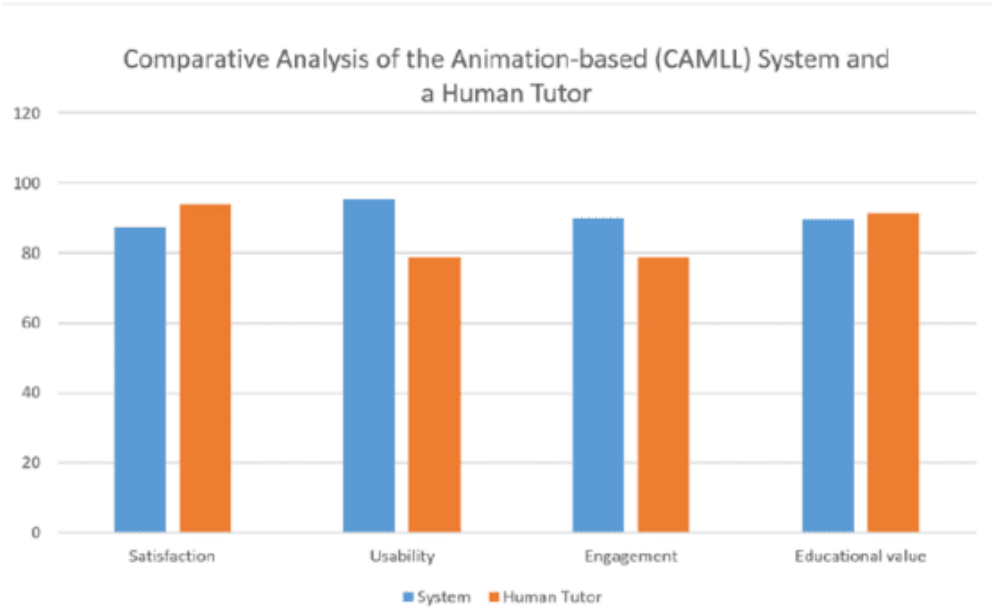


Figure 9: *Comparative Mean Opinion Score Performance of the Developed System and the Human Tutor*

The perceived usability benefit is the greatest effect observed and implies that the system could be regarded as significantly more accessible and easier for the younger learners to use independently than one-on-one human tutoring, likely due to the fact that the interface eliminates the pacing and scheduling constraints of the live tutor. Against this backdrop, the engagement advantage points in the same direction: interactive, visually driven content is more likely to keep a young child focused and interested in the content of the interactive experience, as suggested by the findings on animation and engagement reviewed in Section 2.2.

The small difference in educational value (89% vs. 91%) is a positive result on this parent-reported measure, as the tutor represents unmediated, expert human teaching. Although it may seem more of a superficial measure of satisfaction, it is more informative than it might appear: Where usability and engagement are measures of outcome, satisfaction plausibly reflects the relational dimension of learning warmth, responsiveness to a child's cues, and real-time pacing and encouragement that a set of pre-authored animations cannot yet match. It is easy to detect a child's frustration or boredom in a human tutor and adjust accordingly, but this is not possible in the present system. This interpretation is supported by the pattern for the 4 criteria: the system leads where the task is mechanical or presentational (usability and engagement) and trails, narrowly, where the task is interpersonal (satisfaction) while educational value depends on both being in between.

These comparisons are meant to be descriptive and not inferential. The original evaluation used aggregate percentage MOS scores per group, and not the distribution of individual MOS scores per child, so an independent-samples t-test or other significance test could not be

performed for this analysis, and it cannot be concluded that the differences observed represent a true population-level difference as opposed to sampling error within the relatively small design of 20 per group. This is clearly a limit and not a claim of significance, and we suggest that raw per-participant scores should be kept and analysed inferentially in future replications of this evaluation design. We also do not consider these results as evidence that the system passes a Turing style test of machine intelligence: a MOS satisfaction and usability survey reflects perceived instructional quality, not the ability of the system to be mistaken for a human interlocutor, and these are not synonymous.

5. Discussion

5.1 Implications for Indigenous Language Preservation

On top of the pedagogical outcome, this study offers a digitised and child-oriented path for the N'ko script at a crucial moment in a child's life: their early childhood, which is of key importance for intergenerational language transmission. Incorporating N'ko characters into animated, gamified materials, rather than in a static text-based medium, brings the script into the young children's environments they have already, and provides a valuable addition to documentation-based preservation efforts that are not usually aimed at this age group (Mehta et al., 2020).

5.2 Generalisability to Other Low-Resource Languages

The methodology presented here is a prototyping-based design approach with a mapping of the target language, a Context-Free Grammar model of the target language, direct mapping of culturally relevant characters and assets to interactive exercises, and MOS-based evaluation for human tutoring that is not language-specific. It provides a template that might be easily reused for other African languages with low digitization and few child-friendly learning materials, such as Bambara and Dioula (Joshi et al., 2019). In particular, the grammar-to-exercise mapping described in Section 3.3 is not a Maninka-specific artefact, but rather a re-usable grammar-to-exercise design pattern.

5.3 Limitations

Grammar scope: At this point the CFG model only represents a limited number of simple declarative sentence patterns and does not yet cover negation, question formation, tense/aspect marking and more complex clause structures in Maninka.

Vocabulary size: The size of the vocabulary is kept to a small number of common words drawn from specific semantic categories (greetings, body parts, colours, fruits and vegetables), limiting the range of language that the system can currently learn.

Limited age range and sample size: Pooling children within one 20-participant group (Section 3.6) reduces the precision with which age differences in the effectiveness of the system can be measured.

Single tutor comparison: the human-tutoring condition is based on one native speaker's style of tutoring, and the comparison may therefore BE related to the style of this individual tutor, but not necessarily to human tutoring in general.

5.4 Future Work

i. Expand the CFG model with the addition of negation, question formation, and tense/aspect marking to add more sentence types that the system can teach.
ii. Implement Artificial Intelligence to create a sequence of exercises that are personalized and can adjust dynamically to each child's error patterns and rate of progress, addressing the identified relational gap in Section 4.
iii. Repeat the evaluation using several human tutors and keep the scores for each one of the human tutors, which will allow formal inferential statistical testing of differences between the system and the human tutors.
iv. Use the methodology with other low-resource languages of the Manding or West African branch to directly test the generalisability of the grammar-to-exercise design pattern (Section 3.3).

6.Conclusion

This study designed and tested an Animation Based Computer Assisted Maninka Language Learning System for children between the ages of 2 and 7 years, that incorporates both images, audio, animation and a formally specified Maninka grammar in one interactive system. A Context-Free Grammar model of Maninka sentence structure was built, and more importantly, directly linked to the interactive exercises of the system, making grammar instruction and the use of multimedia one and the same pedagogical design, instead of two. The system was compared to a native speaker human tutor using Mean Opinion Scores for usability, engagement and educational value as reported by parents, and the system was found to be superior in these aspects, with the human tutor being superior in overall satisfaction, a pattern that is consistent with the system being superior at presentation and accessibility, and the human tutor being superior at relational responsiveness. The findings suggest that the developed system could provide young Maninka learners with a viable alternative or complement to human tutoring and also provide a digitised, child-friendly route to the preservation of the N’ko script, and a method for other low-resource African languages to follow for their own early-childhood CALL development.

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