

Investigating Moroccans' Interest in Adopting a New Written System for Darija

Submitted by

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II. Dedications

To my dearest Mom, and Dad. This work is dedicated to you.

Your guidance and unconditional support is the foundation of my love reflected on the world.

III. Abstract

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aequale doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At etiam Athenis, ut e patre audiebam facete et urbane Stoicos irridente, statua est in quo a nobis philosophia defensa et collaudata est, cum id, quod maxime placeat, facere possimus, omnis voluptas assumenda est, omnis dolor repellendus. Temporibus autem quibusdam et aut officiis debitis aut rerum necessitatibus saepe eveniet, ut et voluptates repudiandae sint et molestiae non recusandae. Itaque earum rerum defuturum, quas natura non depravata desiderat. Et quem ad me accedis, saluto: 'chaere,' inquam, 'Tite!' lictores, turma omnis chorusque: 'chaere, Tite!' hinc hostis mi Albucius, hinc inimicus. Sed iure Mucius. Ego autem mirari satis non queo unde hoc sit tam insolens domesticarum rerum fastidium. Non est omnino hic docendi locus; sed ita prorsus existimo, neque eum Torquatum, qui hoc primus cognomen invenerit, aut torquem illum hosti detraxisse, ut aliquam ex eo est consecutus? – Laudem et caritatem, quae sunt vitae.

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1 Introduction

Darija¹ is the vernacular Arabic used by Moroccans. It is mainly spoken and used informally in everyday interactions. Whereas Classical Arabic² is used in formal situations, official media, books, and newspapers. In current times Darija gives a sense of identity and belonging to its speakers, the collective feeling of Moroccanness (Caubet). People want Darija to escape its status as a dialect and develop it into something bigger. This work is an endorsement of this idea and an action toward its actualization.

Darija through most of its history hasn't been written. In past times Moroccans, mostly intellectuals, used Classical Arabic for their writings. Nowadays, with the spread of digital media this is not the case anymore. Most Moroccans don't use Classical Arabic for what they write, while writing on their phones or computers. Given Darija doesn't have a native script, people use either the Latin or the Arabic script to write it. This is limiting in terms of expression and creative freedom. As an example the Arabic script doesn't have a standard representation of the sound "V" that exists in Darija. The Latin script may seem that it can fill the space the Arabic script can't, but it also has its shortcomings. The "ق" sound that exists in Darija, as well in Arabic, doesn't exist in the Latin script. As a result the users of the Language³ use the digit "9" as a substitution for the missing sound. These two examples are not the only ones, but too many to mention.

1.1 Purpose

This paper aims to understand the public's sentiment toward the current written forms of Darija, and the probability of using a completely new written system.

1.2 Significance

- Lay foundation for further investigation on the written forms of Darija.
- Help concerned bodies test the feasibility of standardizing a written system.

1.3 Questions

Given Darija is written using two forms, either with Latin or Arabic:

- Do Moroccans face problems with these current written forms?
- To what extent Moroccans are ready to adopt a completely new written system?

¹Known in Arabic as الدارجة

²Al-Fosha or الفصحى

³Others prefer to label Darija as a dialect

1.4 Hypothesis

Current written forms of Darija are problematic, Moroccans want a completely new written system for Darija.

1.5 Structure of Study

Our study is divided into six sections to comprehensively explore Darija's current written forms. The first section, *Introduction*, provides essential background information on the issue and outlines the specific research questions and purpose that guides this investigation. Following this, the *Literature Review* section synthesizes relevant research on Darija, and identifying any gaps in knowledge that this study aims to address. The third section, *Methodology*, delves into the research design we employed. Here, we detail the method used for data collection and the data analysis technique chosen to examine the research questions. The fourth section, *Findings*, presents the research results in a concise manner. The fifth section, *Discussion*, interprets the meaning of these results in light of the existing literature. Finally, the sixth and concluding section, *Conclusion and Recommendations*, offers a summary of the key findings, along with a discussion of their broader implications. We will also acknowledge any limitations of the study and propose recommendations for future research endeavors that can build upon our findings.

2 Literature Review

Scholarly work previously done on Darija focus primarily on its vocabulary, grammar, and phonological characteristics.

2.1 Vocabulary

Most of Darija's lexicon is derived from classical Arabic (Duri). Tamazight⁴ also played an important role in the development of Darija's vocabulary (Chtatou; Sadiqi). As well French and Spanish during the colonial period in Morocco (Burke).

2.2 Grammar and Phonology

The similarity between Darija and Classical Arabic ends in vocabulary. It starts to deviate from Al-Fusha toward the Tamazight grammatical and phonological features (Rouchdy). The difference is appearing in the compression of vowels, a great divergence in its phonology, and unsimilar sentence structure (SVO⁵ as opposed to the VSO⁶ in Al-Fosha).

⁴Or Berber, a term we do not prefer to use

⁵Subject-Verb-Object

⁶Verb-Subject-Object

2.3 Gap

While these studies provide valuable insights to the researcher on Darija, they stand short in presenting a practical framework that benefits its development. The Moroccan variety is understudied in its written forms. Plus there has been no attempt to test it with a completely new written system. So it is our duty to do so, as in this paper.

3 Theoretical Framework

3.1 Standardization

Language standardization, as in language policy and planning, is the process of elevating a language variety to a standard form (Einar Haugen). Through a four stage process: *selection* of the variety to elevate to a standard, *codification* of its rules by creating documentations, dictionaries, and grammar books, *elaboration of function* in various domains (i.e. education, media, administration, literature, etc.), and at last the *acceptance* of the developed variety by the mass speech community it is designed for (EINAR Haugen). While this process may seem ideal and effortless to the recipient and happens naturally, it is not. It requires coordinated effort from various actors and involvement of multiple parties. Otherwise, the result is undesired to the speakers of the unstandardized variety as stated by (Crystal).

Darija is unstandardized. And debates are rising, whether it is a language or a dialect. We argue it is a language. Because it has unique grammatical features and different phonology than the argued parent variety *Standard Arabic*. Moreover, while Darija seems to have a rich culture; it does not have a standard written system. Which puts it in an awkward position toward its standardization.

3.2 A New Written System

There are three types of written systems (Forrester). One, *logographic*, where full words or ideas are represented by a shape. Two, *syllabic*, where an individual item (letter or shape) represents a syllable. And three, *alphabetic*, where each letter represents a phoneme (sound). All contemporary written systems sit in one of these categories. In example, Chinese is logographic, the Vai script, used in Liberia, is syllabic, and Latin is alphabetic. Though, other written systems use more than one. As Japanese, which is composed of three scripts, two syllabic (Hiragana and Katakana), and one is logographic, the Kanji. All of these systems proved their correctness and usefulness in representing language in a written form, yet they vary in difficulty of learning. Logographic being the hardest and alphabetic the easiest (Forrester).

Developing a new written system for Darija should be alphabetic, for easiness of learning and application. Also, it should consider the big effects that Classical Arabic has on Darija in its history and vocabulary; while not dismissing the need of visual uniqueness and reflection of the Moroccan identity, even though this is subjective, the pursuer of such a job should consider it. And most importantly, the written system should be sufficient for representing Darija correctly and completely; in contrast to the current non standard forms using the Latin and the Arabic scripts.

This study proposes a new written system with consideration to these requirements. That is alphabetic, and contains 30 consonants and 6 vowels.

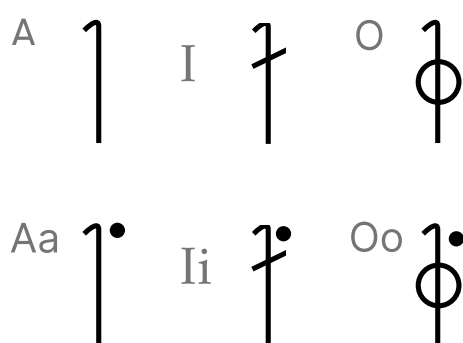


Figure 2: Vowels: 3 short + 3 long.

There are only 3 vowels for simplicity. When a dark dot added they are lengthened.

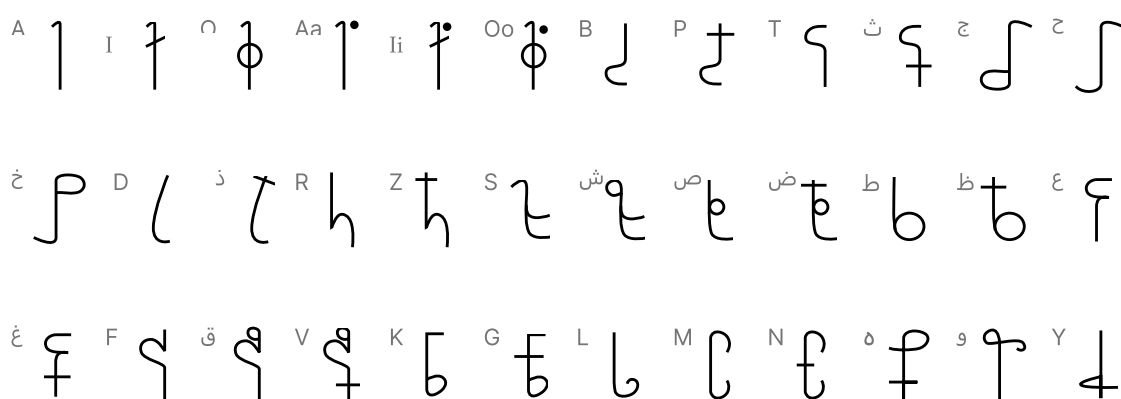


Figure 3: The full alphabet.

The coding behind this alphabet is following the exact coding of the Arabic alphabet. Similar letters in Arabic are similar in this alphabet too. This makes it easy to learn and remember for

the seeker familiar with the Arabic alphabet. In addition, it includes the missing sounds (or non standard ones) used by Darija and absent in Arabic.

This was created to test to what extent Moroccans are ready to adopt a completely new written system, as in the 2nd research question. This alphabet is used for writing Darija mimicking a native script. An online keyboard and a quiz were made to test if the participants in this research will be able to read and write using it (more about this in the *Methodology* Section).

4 Methodology

4.1 Research Approach and design

This study followed a quantitative research approach. Due its offer of an objective, formal, and systematic process to test our hypothesis and describe why or why not Moroccans want a completely new written system.

A descriptive survey was employed. This was chosen to examine the current levels of interest, attitudes, and perceptions among Moroccans, concerning Darija's current written forms. A structured questionnaire was used. Designed with close ended questions to assess respondents' interest and attitudes. The survey was distributed online to a sample of Moroccan residents to ensure broader and appropriate coverage. The data collected from this survey will provide comprehensive insights about the population's views on the current written forms of Darija, as well the new one. Helping in evaluating key factors influencing their interests.

4.2 Research Setting, Population, and Sample

This study was conducted in Morocco. Because, when speaking about Darija it is mainly concerned with the Morocco region in North Africa. The population of this study consisted of Moroccans, between the age of 5 and 70 years old, with the will to participate.

A convenient sample of 63 people was selected. This sample included a diverse set of Moroccans with different ethnicities, ages, and language preferences. But, unified with the use of Darija in everyday interactions. Available participants were handed an online questionnaire to fill during a period of 7 days. Participants included in the sample were selected because they met this selection criteria. That they are Moroccan residents, between the age of 5 and 70, mentally sound, willing to participate, and of any sex or any race.

4.3 Data Collection Instrument and Procedure

A questionnaire was chosen to collect data. That will help evaluate Moroccans attitudes and perceptions about the current written forms of Darija and the new written system we created. A questionnaire was used because it allows high response volumes, requires less energy and time to administer, anonymous, less biased, and easy to compare responses.

Three questionnaires were used to collect the data. One in English, one in Arabic, and one in French. Because of Morocco's multilingual ground and to ensure broader participation. They were distributed and shared to participants, primarily in Moulay Ismail University in Meknes and on social media. Which upon finalizing of data collection, responses were combined and translated to English.

The survey was composed of two sections [See Appendix I]. Section 1 was concerned with the current written forms of Darija. After collecting the usual demographic data about participants, the questions were interested with the participants' views about using Arabic and Latin for writing Darija. Section 2 was concerned with the new written system: after finishing the first section the participants were asked if they wanted to try a new written system, to measure interest in such idea. Participants responded positively were taken to a fully guided introduction to the new written system. Then to a small quiz of 6 questions [See Appendix II]. Presenting small Darija words for them to read or identity, using the full new alphabet reference included with the quiz [See Appendix III]. After finishing the quiz participants were given their scores and an option to try a custom made keyboard of the new alphabet for writing freely in it [See Appendix IV]. All of this was to help participants build attitudes and views about the new written system that they will tell us about in section 2 of the questionnaire.

4.4 Reliability and Validity

The questionnaires were distributed with very minimal interference. Also, they were online based, using Google Forms, so no direct interaction with the researcher was possible minimizing errors and biases. And through standardized conditions where similar personal attributes were exhibited to all the participants. The questionnaires were based on knowledge gathered during the literature review to ensure they were aligned with the current state of Moroccan society. The questions were in a simple language for ease of understanding. And clear guidance and instructions were included from start to finish.

For validity, participants were required to include their emails. This was enforced by Google to avoid the same participant from filling the questionnaires more than once. However, to ensure anonymity of the participants and their privacy, their emails were turned into *hashes* using the *sha-256* algorithm. It turns input given to it into a hash that can't be reversed to its original content, [See Appendix V]. So the same emails will result the same hash, indicating duplication of answers. This resulted in a valid and anonymous data set.

4.5 Ethical Considerations

To render this study ethical, the rights of anonymity, confidentiality, determination, and informed consent were assured.

The consent of subjects was obtained before filling the questionnaire. The participants were informed of their rights to voluntarily consent or decline to participate, and withdraw and edit their response, at anytime during the week of data collection, without any penalty. They were also informed about the purpose of this study and the procedure that will be followed.

Anonymity and confidentiality guidelines were followed throughout the course of the study. The participants cannot be linked, even by the researcher, with their responses. In this study anonymity was proven by not collecting participants names on the questionnaire and protecting their emails with industry standards to not be used for any purpose except for data validation.

4.6 Data Analysis

After the data was collected and organized it was analyzed. For analysis of closed-ended questions, a computer programme called Google Sheets was used. Data was analyzed and presented in pie diagrams and bar graphs.

4.7 Conclusion

We used a quantitative, descriptive survey design. Three questionnaires were handed in English, Arabic, and French to the participants. To collect the data from a convenient sample of 63 subjects. The questionnaires had close ended questions. The sample characteristics included Moroccans who were mentally sound and use Darija daily, and were willing to participate.

Consent was obtained from the participants. Anonymity, self-determination and confidentiality were ensured during administration of the questionnaires and in report writing. Questionnaires were distributed to subjects online using Google Forms. Data collected for a period of 7 days. Then organized, translated, and transformed into diagrams and charts.

5 Findings

Our findings are organized into 18 results. Each with correspondence to a questionnaire question.

5.1 Result One

Gender

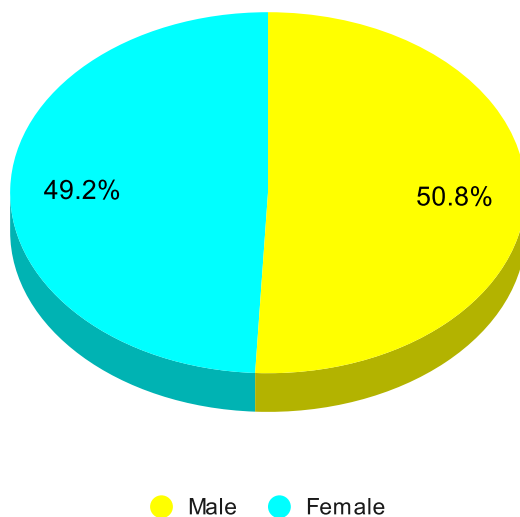


Figure 4: Participants's gender.

Participants' gender was symmetric. Roughly, half females, and half males.

5.2 Result Two

Age

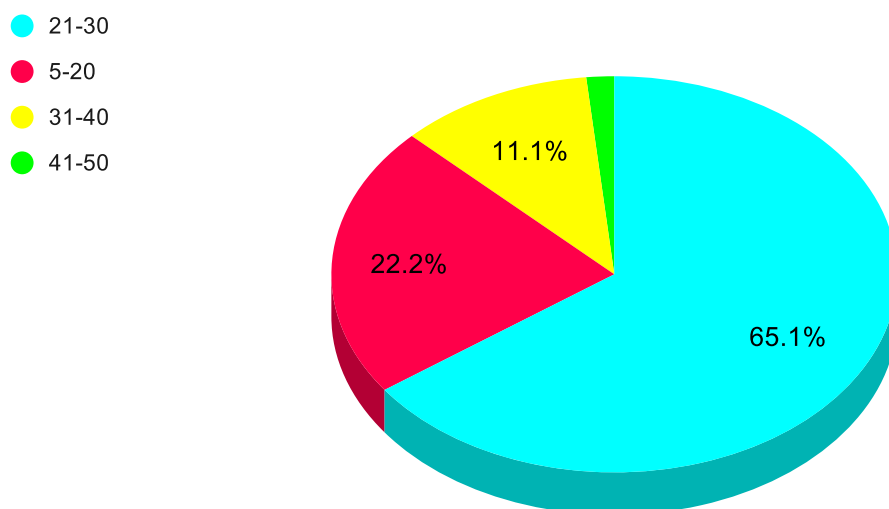


Figure 5: A pie chart showing participants' age.

Most of respondents age between 21 and 30 years old. Followed by a modest amount less than 20 years old. And a small fraction between 31 and 40. And none aged 41 or more.

5.3 Result Three

How important is Darija to your Moroccan identity?

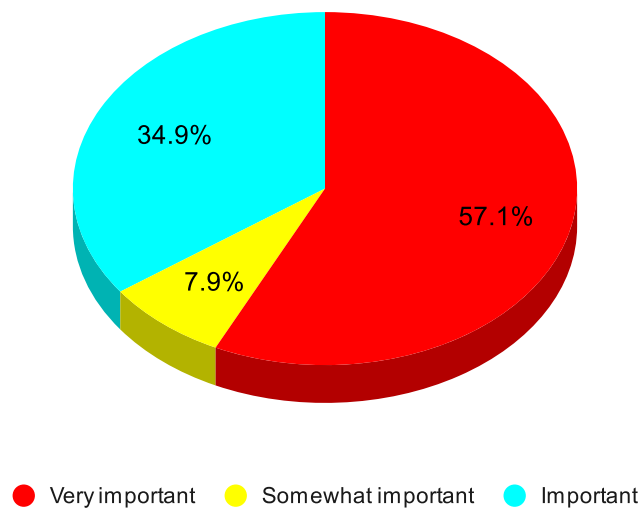


Figure 6: A pie chart showing Darija importance for Moroccans' identity.

The majority considers Darija is very important to their Moroccan identity. A notable portion of participants considers it important to somewhat important. While no one indicated it is not important for their Moroccaness.

5.4 Result Four

Do you believe Darija is a legitimate language?

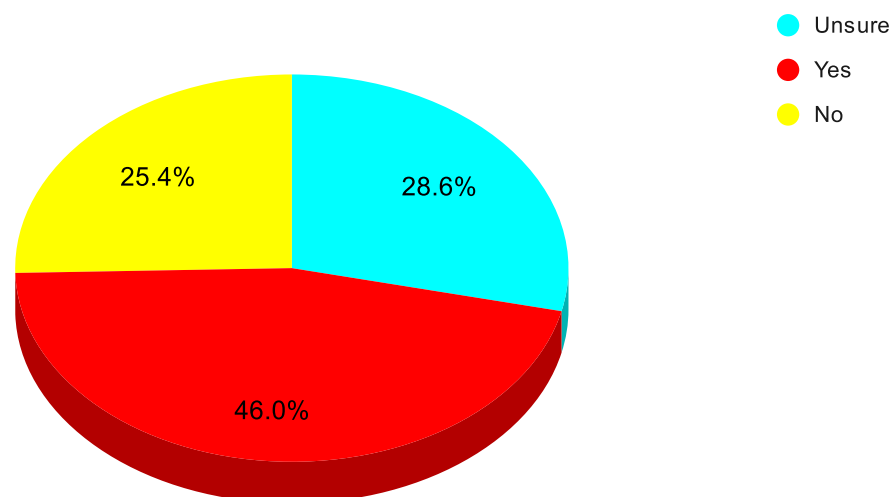


Figure 7: A pie chart presenting Moroccans's conception of Darija.

Almost half of respondents think Darija is a language. A modest minority is unsure. The rest thinks Darija is not a language.

5.5 Result Five

How comfortable are you reading and writing Darija in Arabic?

Comfortable Very comfortable Not comfortable at all Somewhat comfortable

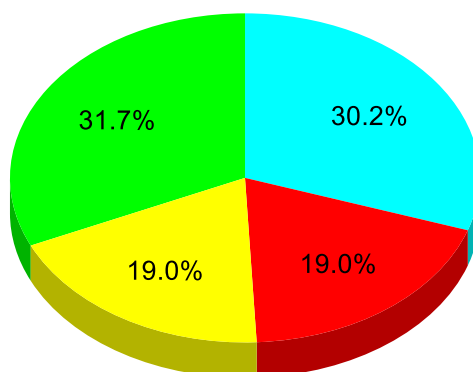


Figure 8: A pie chart presenting Moroccans's comfort in writing Darija in Arabic.

The majority feels somewhat comfortable, comfortable, to very comfortable in writing Darija using Arabic. While a small minority is not comfortable at all.

5.6 Result Six

Do you find writing using Arabic suitable for Darija?

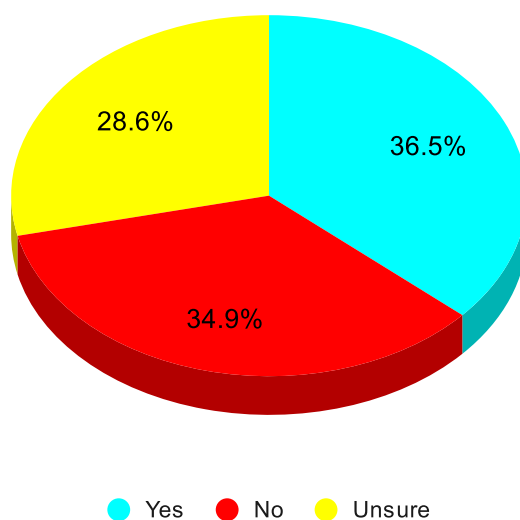


Figure 9: A pie chart showing if Moroccans think Arabic is suitable for Darija.

A third thinks Arabic is suitable for Darija. The second third thinks it is not. While a third is unsure.

5.7 Result Seven

Why you don't find Arabic suitable for writing Darija?

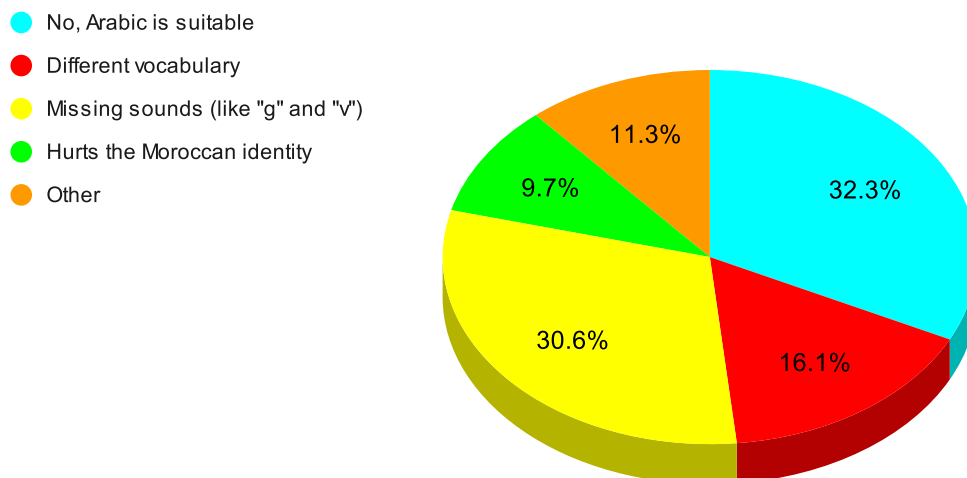


Figure 10: A pie chart showing why Arabic isn't suitable for Darija.

A third thinks Arabic is suitable for Darija as presented in the previous result. The second third thinks it is not suitable for Darija because of the missing sounds. A minority also thinks it is not suitable because of the different vocabulary. And some others also thinks it hurts the Moroccan identity.

5.8 Result Eight

How comfortable are you in reading and writing Darija in the Latin alphabet?

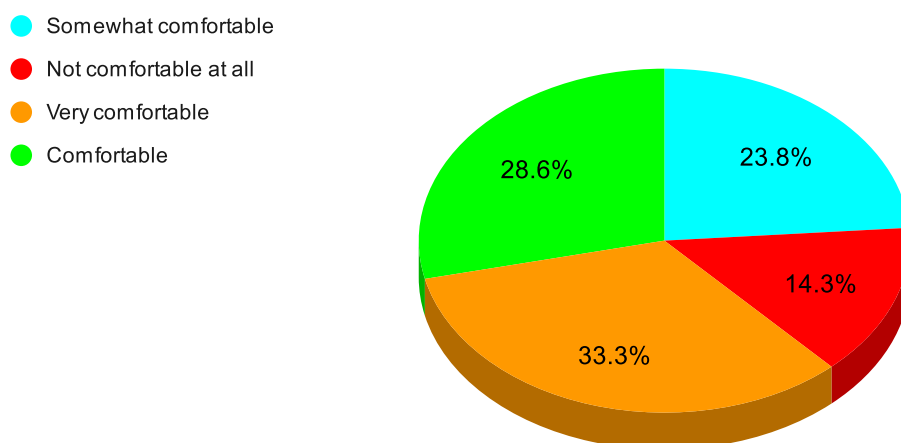


Figure 11: A pie chart presenting Moroccans's comfort in writing Darija in Latin.

The majority stated they are somewhat comfortable, to very comfortable in using Latin for writing Darija. While only a minority are not comfortable at all.

5.9 Result Nine

Do you find writing using the Latin alphabet suitable for Darija?

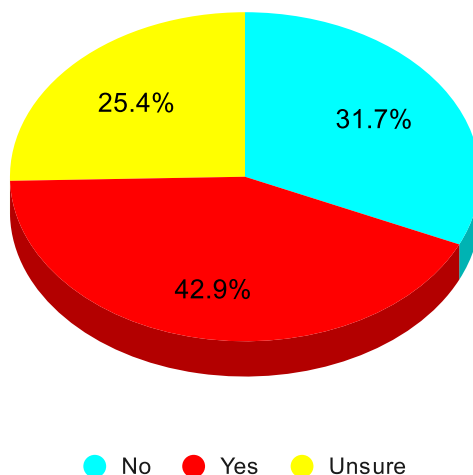


Figure 12: A pie chart showing if Moroccans think Latin is suitable for Darija.

Almost half thinks Latin is suitable for Darija. A third thinks it is not. The rest is unsure.

5.10 Result Ten

Why you don't find the Latin alphabet suitable for writing Darija?

- Missing sounds (like "ق", "ع", "خ", etc)
- Hurts the Moroccan identity
- No, Latin is suitable for Darija
- Different vocabulary

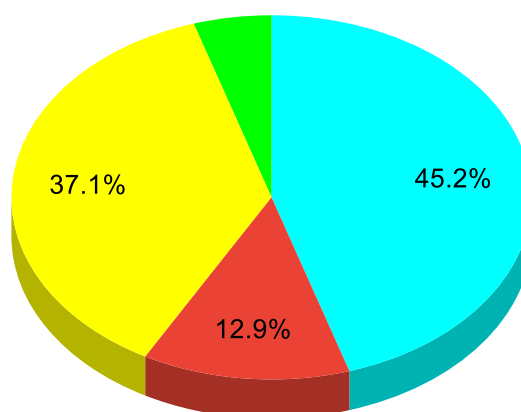


Figure 13: A pie chart showing why Latin isn't suitable for Darija.

A significant portion thinks Latin is suitable, same as in the previous result. But, almost a half thinks Latin is not suitable for Darija because it has missing sounds. And a minority thinks it is not suitable because it hurts the Moroccan identity.

5.11 Result Eleven

In your opinion, would adopting a new writing system for Darija be beneficial for Morocco?

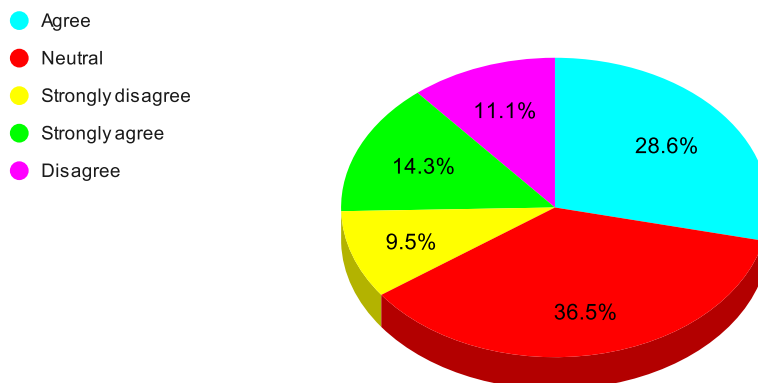


Figure 14: A pie chart showing opinion about the benefit of Morocco from the adoption of a new written system.

The biggest third are neutral. The second biggest third agree with the statement that Morocco would benefit from adopting a new written system for Darija. The rest disagree to strongly disagree with this statement.

5.12 Result Twelve

If a new writing system for Darija were to be developed, what features would you consider important?

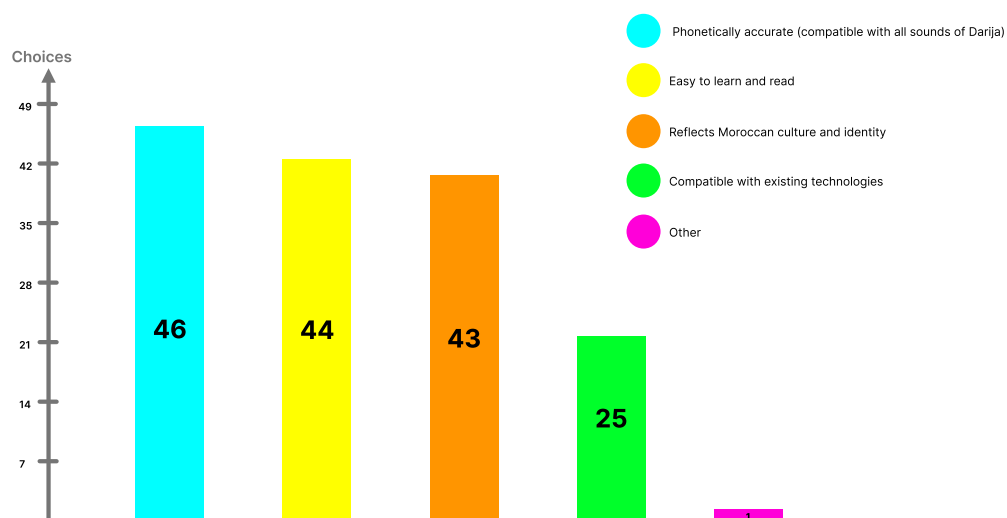


Figure 15: A bar chart showing the features of a new written system if to be developed.

A large portion wants the new system to be phonetically accurate, easy to learn and read, and reflects the Moroccan identity. And also compatible with existing technologies, but not stressed on the same as the aforementioned features.

5.13 Result Thirteen

We have developed one, would you like trying it?

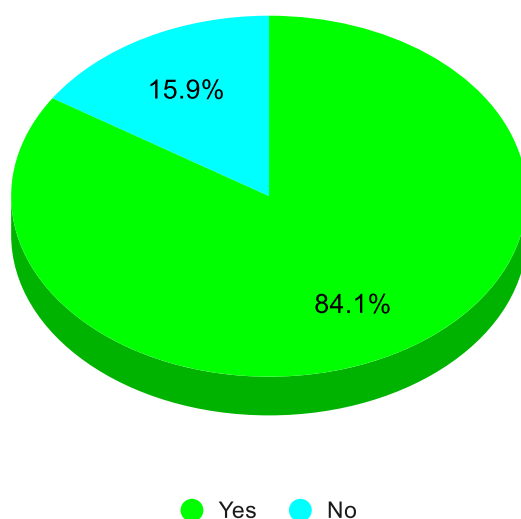


Figure 16: A pie chart showing the interest in trying a new written system.

The majority showed interest in trying the new written system. But, only a minority did not.

5.14 Result Fourteen

After trying the new alphabet for Darija, how easy did you find it to learn the basic characters?

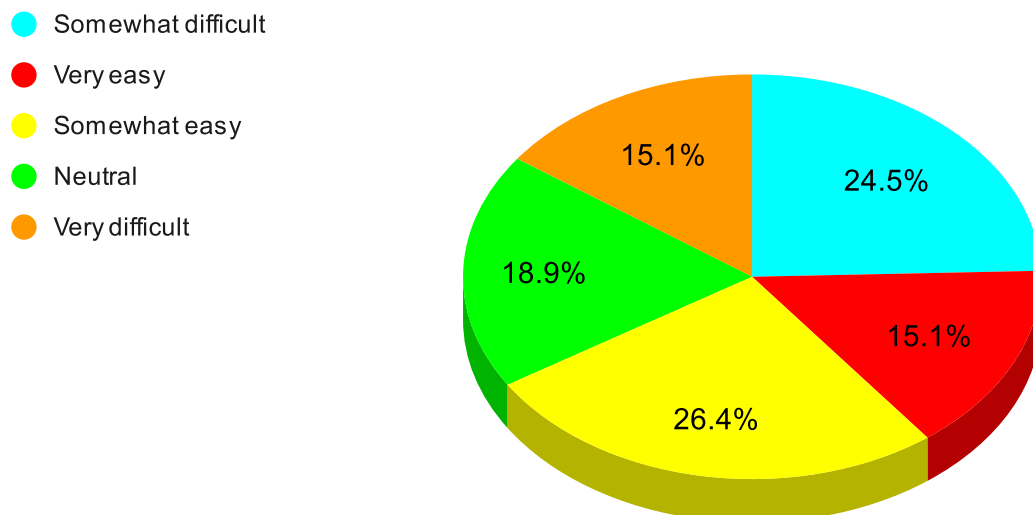


Figure 17: A pie chart about how the participants found the new written system.

Opinions were not so apparent. But the first biggest portion found it somewhat easy to very easy.

While the second largest portion found somewhat difficult to very difficult. The rest were neutral.

5.15 Result Fifteen

Did the new alphabet seem intuitive in representing the sounds of Darija?

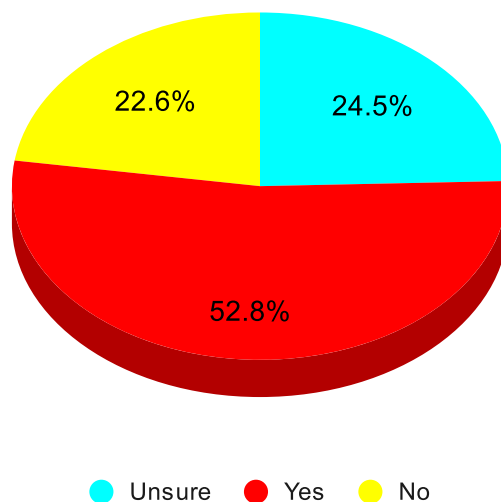


Figure 18: A pie chart representing if the new written system was intuitive, according to participants.

Half said the new written system was intuitive. A quarter were unsure. The rest quarter said the new written system was not intuitive.

5.16 Result Sixteen

Were you able to read simple Darija words using the new alphabet?

- No, but I think I could learn with practice
- Yes, with ease
- Yes, with some effort
- No, and I don't think it would be easy to learn

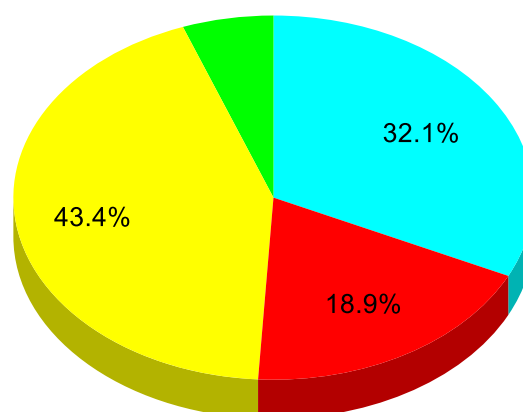


Figure 19: A pie chart showing participants ability to read in the new written system.

The majority were able to read words using the new written system. A third were not, but mentioned they could learn with practice.

5.17 Result Seventeen

Compared to the Latin and Arabic scripts, how comfortable do you feel using this new alphabet for Darija?

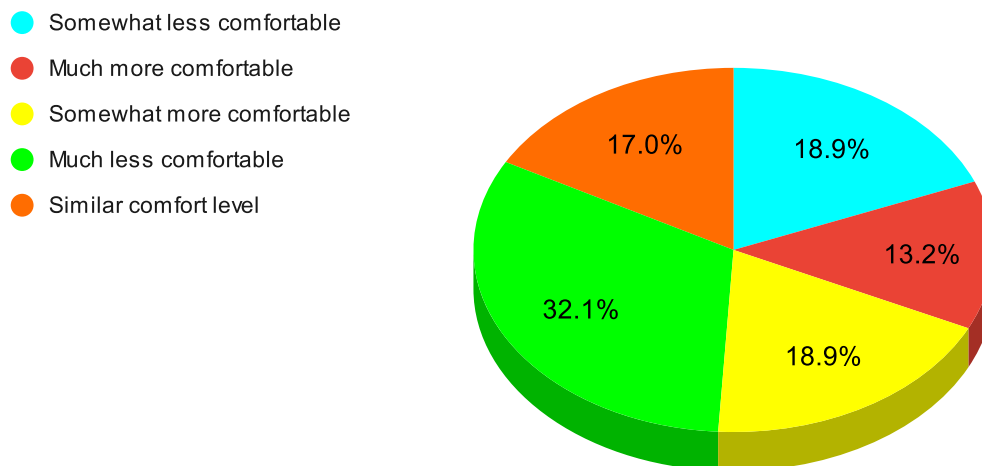


Figure 20: A pie chart showing participants comfort using the new written system compared to the old ones.

The majority were uncomfortable using the new written system in comparison to using Arabic or Latin. A minority stated it was on similar comfort. While the rest stated they were comfortable.

5.18 Result Eighteen

What are some of the strengths you see in this new alphabet for writing Darija?

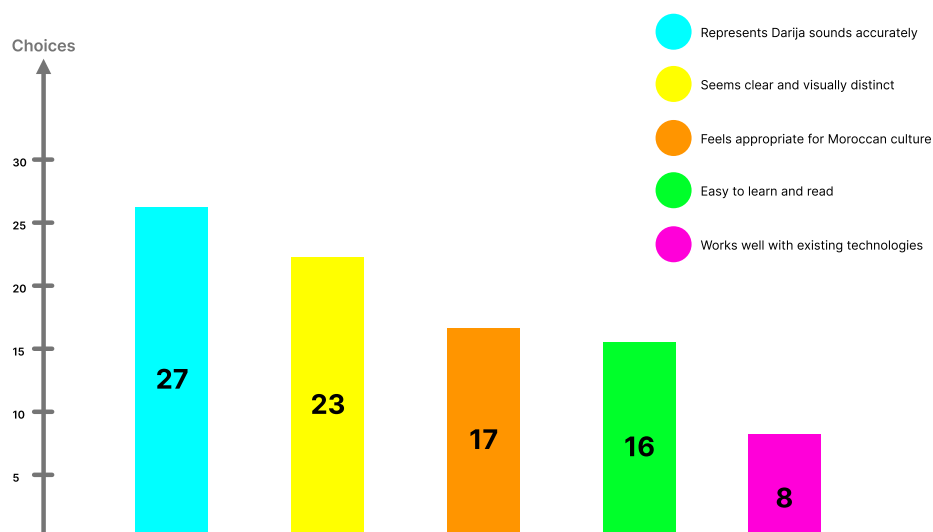


Figure 21: A bar chart showing the features of the new written system, according to participants.

The majority of choices were that the new written system represents Darija sounds accurately, and that it seems clear and visually distinct. Followed by choices on that it feels appropriate for the Moroccan culture, and easy to learn and read. The least of choices were on that it works well with existing technologies.

6 Discussion

This study confirms that Darija gives a sense of identity to Moroccans, as was stated by (Caubet). Also the current written forms are thought to be enough and suitable for Darija, yet not perfect. The speakers face troubles with the incompleteness of the Latin and the Arabic scripts as a writing method for Darija. Due to the missing sounds and identity issues concerning the use of these scripts. Moreover, it was shown if a new writing system were to be developed preferably it should be complete for representing Darija, easy to learn and read, and reflects the Moroccan identity while being compatible with existing technologies.

There was a substantial interest in trying the new written system. Despite that, results weren't that clear to draw a firm conclusion about the easiness of the new alphabet. Maybe because of the limited exposure to the alphabet or lack practical use on a daily basis. The new writing system was thought to be a complete form suitable for Darija. Showing the effect of using a thoughtful and inherently complete design for its writing.

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Appendices

Appendix I: The Questionnaire (English Version)

Ways of Writing Darija

This questionnaire is part of a research project.

We are very interested in understanding your thoughts and experiences. Your honest responses are crucial to this research and will be kept strictly confidential. They will only be used for research purposes and will not be linked to you in any way.

Thank you for your time and willingness to contribute.

Section 1

Gender

- *Male*
- *Female*

Age

- *5-20*
- *21-30*
- *31-40*
- *41-50*
- *51-60*
- *61-70*

How important Darija is to your Moroccan identity?

- *Not important at all*
- *Somewhat important*
- *Important*
- *Very important*

Do you believe Darija is a legitimate language?

- *Yes*

- *No*
- *Unsure*

How comfortable are you reading and writing Darija in Arabic?

- *Not comfortable at all*
- *Somewhat comfortable*
- *Comfortable*
- *Very comfortable*

Do you find writing using Arabic suitable for Darija?

- *Yes*
- *No*
- *Unsure*

Why you don't find Arabic suitable for writing Darija?

- *Missing sounds (like “g” and “v”)*
- *Different vocabulary*
- *Hurts the Moroccan identity*
- *No, Arabic is suitable*
- *Other: ...*

How comfortable are you in reading and writing Darija in the Latin alphabet (ABCDEF...)?

- *Not comfortable at all*
- *Somewhat comfortable*
- *Comfortable*
- *Very comfortable*

Do you find writing using the Latin alphabet suitable for Darija?

- *Yes*
- *No*
- *Unsure*

Why you don't find the Latin alphabet suitable for writing Darija?

- *Missing sounds (like “ح“ , ”ع“ , ”ق“ , etc)*
- *Different vocabulary*
- *Hurts the Moroccan identity*
- *No, Latin is suitable for Darija*
- *Other: ...*

In your opinion, would adopting a new writing system for Darija be beneficial for Morocco?

- *Strongly disagree*
- *Disagree*
- *Neutral*
- *Agree*
- *Strongly agree*

If a new writing system for Darija were to be developed, what features would you consider important? (Select all that apply)

- *Easy to learn and read*
- *Phonetically accurate (compatible with all sounds of Darija)*
- *Reflects Moroccan culture and identity*
- *Compatible with existing technologies*
- *Other: ...*

We have developed one would you like trying it?

- *Yes*
- *No*

Section 2: Trying the new writing system

Please visit this new writing system demo (<https://darija-quiz.vercel.app/>). Then comeback and tell us what you think about it.

After trying the new alphabet for Darija, how easy did you find it to learn the basic characters?

- *Very easy*
- *Somewhat easy*
- *Neutral*
- *Somewhat difficult*
- *Very difficult*

Did the new alphabet seem intuitive in representing the sounds of Darija:

- *Yes*
- *No*
- *Unsure*

Were you able to read simple Darija words using the new alphabet?

- *Yes, with ease*
- *Yes, with some effort*
- *No, but I think I could learn with practice*
- *No, and I don't think it would be easy to learn*

Compared to the Latin and Arabic scripts, how comfortable do you feel using this new alphabet for Darija?

- *Much more comfortable*
- *Somewhat more comfortable*
- *Similar comfort level*
- *Somewhat less comfortable*
- *Much less comfortable*

What are some of the strengths you see in this new alphabet for writing Darija?

[Multiselect]

- *Easy to learn and read*
- *Represents Darija sounds accurately*

- *Seems clear and visually distinct*
- *Feels appropriate for Moroccan culture*
- *Works well with existing technologies (computers, displays)*
- *Other: ...*

Do you have any suggestions for improvement for this new alphabet

- ...

Appendix II: The Quiz Tool

The quiz tool is a web site. It contains an interactive introduction to the alphabet. Plus a simple 6 questions quiz. It is available at <https://darija-quiz.vercel.app>, as of 2024. Contact us if the site is not available in the future.

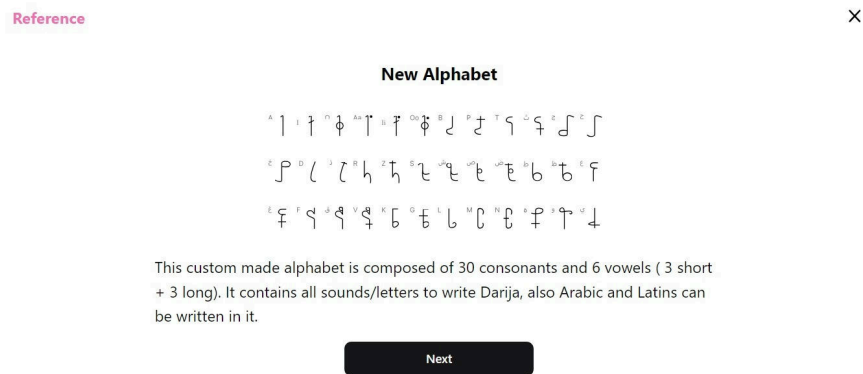


Figure 22: A screenshot of the 2nd step of the alphabet introduction.

The introduction is used to familiarize the participants with the completely new written system.

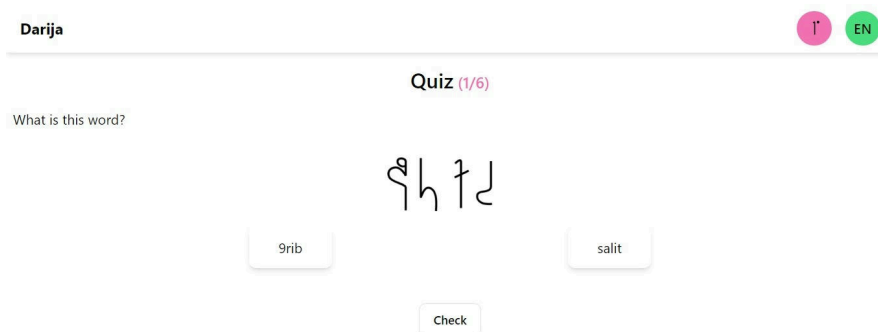


Figure 23: A screenshot of a question from the quiz.

This quiz will help the participants test if they can read basic words in this new alphabet.

Appendix III: The Quiz Alphabet Reference

Reading words in a completely new and unfamiliar written system is very hard. This why the quiz included a reference to the alphabet used for writing the words. Making it easier for the participants to identity them.



Figure 24: A screenshot of the alphabet reference from the quiz.

Appendix IV: The Custom Keyboard

Text support may seem straightforward and easy to integrate on digital devices, it is not. It requires multiple bodies working together to implement and standardize. Then at the end brought to computers and digital devices. This is of course beyond the power of one person. So we had to come up with a solution for participants to try writing using the new alphabet. The solution was this custom keyboard, available at <https://darija-demo.vercel.app>, as of 2024.

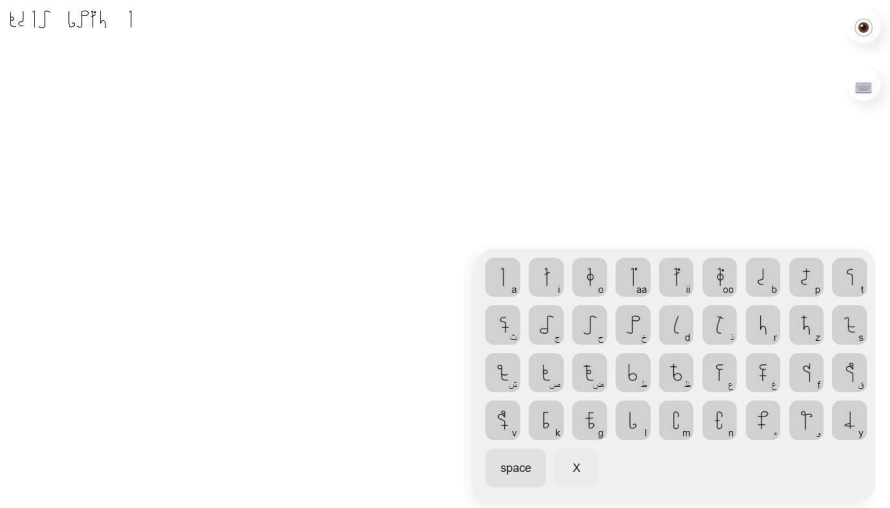


Figure 25: A screenshot of the alphabet's custom keyboard.

Appendix V: Hashing and SHA-256

Explained with great details at <https://en.wikipedia.org/wiki/sha-2>