



The Role of Code Switching and Code Mixing in the Teaching and Learning Process at the Institute of Adult Education, Mwanza Campus, Tanzania

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Abstract

This qualitative study explores the pedagogical role of code-switching and code-mixing in multilingual adult education classrooms at the Institute of Adult Education (IAE) Mwanza Campus, Tanzania. Drawing on the Linguistic Interdependence Hypothesis, the research examines how these linguistic practices enhance comprehension and learning in contexts where English is the medium of instruction, but Kiswahili serves as learners' dominant first language. Data were collected via semi-structured interviews with 8 facilitators and 42 students, alongside non-participant observations of 10 classroom sessions. Thematic analysis revealed that code-switching and code-mixing are used primarily for clarification, translating technical terms, and fostering inclusivity. Findings indicate these practices promote knowledge transfer from L1 to L2, reduce cognitive load, and improve engagement, aligning with recent evidence from multilingual African contexts. Recommendations include integrating bilingual strategies into teacher training and developing multilingual curricula to support adult learners in similar settings.

Keywords: code switching, code mixing, learning process, multilingual pedagogy, linguistic interdependency hypothesis, adult learning

Introduction

Tanzania's multilingual society features Kiswahili as the national language, English as the official medium in higher education, and over 120 ethnic languages. At the IAE Mwanza Campus, adult learners pursue certificates and diplomas in fields like community development, with English as the designated medium despite most learners' stronger proficiency in Kiswahili. Code-switching (CS) and code-mixing (CM) are common linguistic phenomena in educational settings. CS refers to the alternation between two or more languages or dialects within a single conversation

or utterance (Huda et al., 2025), while CM involves the integration of linguistic elements from one language into another to enhance expression or style (Kridalaksana, 2023). These practices are widespread in bilingual classrooms, facilitating communication and learning (García & Wei, 2014).

This study investigates the role of CS and CM in teaching and learning at the Institute of Adult Education (IAE) Mwanza Campus, where adult learners pursue certificates and diplomas in adult education and community development. Facilitators and students frequently switch between English (the official medium) and Kiswahili (L1) to clarify concepts and ensure comprehension. Grounded in the Linguistic Interdependence Hypothesis (LIH), which posits that proficiency in L1 supports second language (L2) development through skill transfer (Clayton, 2024), the research aims to identify the role of CS/CM and their pedagogical impacts.

Recent studies highlight the relevance of CS/CM in African higher education, where they bridge linguistic gaps and promote transformative learning (Mtawa et al., 2025). For instance, in multilingual contexts, CS facilitates identity negotiation and cultural inclusivity (Kipchoge, 2024). In bilingual settings, this interdependence enables learners to leverage L1 resources for L2 acquisition, reducing barriers in English-medium instruction (Clayton, 2024). Recent applications in African contexts demonstrate that strong L1 literacy predicts better L2 outcomes, supporting the use of CS/CM as scaffolding tools (Sibanda & Tshehla, 2025).

CS and CM are integral to multilingual education, enhancing comprehension and engagement (Alsalem & Elsayy, 2025). In classroom interactions, CS patterns include intra-sentential (within sentences), inter-sentential (between sentences), and tag-switching (adding tags like interjections) (Lavadia et al., 2025). Functions range from clarifying meanings and reiterating concepts to building rapport and managing classroom dynamics (Telic et al., 2025).

Reasons for CS/CM in educational settings include overcoming vocabulary gaps, emphasising points, and fostering solidarity (Mustafayeva et al., 2025). In English as a Foreign Language classroom, teachers use CS to reduce student stress and increase participation (Alsalem & Elsayy, 2025). In African multilingual societies, CS negotiates power relations and cultural identities, countering monolingual policies (Ramaila, 2025). For example, in South African schools, shifting to English as the medium often leads to CS for better understanding (Sibanda & Tshehla, 2025).

CS also boosts cognitive processes, such as attention and memory, for bilinguals (Salig et al 2025). In higher education, it supports transformative practices by valuing

local languages (Mtawa et al., 2025). However, challenges like stigmatisation persist, necessitating policy reforms (Khan et al., 2025).

According to Muthusamy et al. (2020), factors that influence CS and CM were that participants stated different reasons why they resorted to CS and CM in their interactions. Factors affecting CS extracted from the interviews with the participants are as follows: lack of competence in the second language, preserving privacy, the ease of speaking in one's own language, avoiding ambiguity and misunderstanding, the lack of similar words in English, unawareness of the equivalent English term or phrase, bridging the gaps while speaking, showing intimacy, adding emphasis, drawing attention, and pragmatic reasons.

Anyanwu (2022) role of Code Switching and mixing in the Teaching and learning of the English language as a second language, from the perspective of both students and teachers. It revealed that code-switching and mixing (especially in Igbo and English) instil confidence amongst students to express their language inadequacies, learn freely and improve on the target language. It also allows students to express their understanding of language activities in the target language to the teacher, using appropriate feedback in the L1. The result of the students' questionnaire generally confirmed the effectiveness of code switching and mixing in the teaching and learning of the English language as a second language.

The function of code switching and mixing is to draw attention of the students to talk about a particular topic. The teacher used code-mixing in the teaching-learning process in the classroom in order to get or to catch the students' attention to learn. When the teacher mixed his language in delivering the lesson, the students paid more attention to the lesson being taught. It helps the students to understand the lesson easily. Then, the teacher used it to make a warm situation in the class; thus, it helps the teacher build a relation to learning with the students. Thus, it is hoped that the students will enjoy learning English. The other functions of code-mixing to show off, impress personal purposes, impress the opposite sex, and eliminate a group from the conversation were not found in this research. (Said, 2021).

Methodology

This qualitative study employed a case study design at IAE Mwanza Campus from September to November 2024. Participants included 8 purposively selected facilitators (from 15 teaching English modules) and 42 randomly selected adult learners in certificate (levels 4–5) and diploma (level 6) programmes. The qualitative approach was used to analyse data obtained, where data were categorised according

to their relevant themes and patterns developed accordingly. Table 1 shows the participant sampling grid.

Table 1: Participant Sampling Grid

S/N	Type of Respondent	Total Population	Sample Size	Percentage (%)
1	Facilitators	15	8	53.3
2	Students-Basic Technician Certificate (level 4)	11	5	45.5
3	Students-Technician certificate (level 5)	75	18	24.0
4	Students-Ordinary Diploma (level 6)	73	19	26.0
Total		174	50	100%

Percentages for facilitators are calculated relative to the facilitator population ($8/15 \times 100$) while percentages for student subgroups are calculated relative to each subgroup's population. The overall sample represents approximately 28.7% of the total population (50/174).

Data collection method involved semi-structured interviews to capture participants' experiences and opinions, and non-participant observations of 10 sessions (60–120 minutes each) to document CS/CM. All information that was collected from interviews and the classroom observation schedule was subjected to content analysis, which involved identifying coherent and important examples, themes and patterns in data collected from the fieldwork. The qualitative approach, therefore, was used to analyse data obtained, where data were categorised according to their relevant themes and patterns developed accordingly. Ethical considerations included informed consent, anonymity (pseudonyms used) and institutional approval.

Observation sessions on code switching and code mixing in adult education classes

The following table summarises 10 classroom observation sessions conducted between September and November 2024. These observations focused on the use of code-switching (CS) and code-mixing (CM) between Kiswahili and English by facilitators and students in various programs and modules at an adult education institution. Observations were conducted as non-participant studies across 10

sessions between September and November 2024 to capture the natural occurrences of code-switching and code-mixing.

Table 2: Classroom Observation Schedule

Session No.	Date	Programme Level	Module Observed	Duration (minutes)	Key Focus of Observation
1	September 15, 2024	Basic Technician Certificate (Level 4)	English Grammar	90	Use of CS/CM in explaining grammar rules
2	September 20, 2024	Technician Certificate (Level 5)	Information and Communication Technology (ICT)	120	Translation of technical terms
3	September 28, 2024	Ordinary Diploma (Level 6)	Philosophy of Adult Education	80	Clarification of abstract concepts
4	October 5, 2024	Basic Technician Certificate (Level 4)	Communication Skills	60	Task instructions and classroom management
5	October 12, 2024	Technician Certificate (Level 5)	Management of Literacy Classes	100	Student seminar presentations
6	October 18, 2024	Ordinary Diploma (Level 6)	Adult Education Methods	90	Building rapport and emotional feedback
7	October 25, 2024	Mixed (Levels 4–6)	General Discussion/Session	75	Spontaneous CS/CM in interactions
8	November 2, 2024	Technician Certificate (Level 5)	ICT Practical	120	Operational instructions
9	November 9, 2024	Ordinary Diploma (Level 6)	Seminar Presentation	110	Peer clarification during presentations
10	November 15, 2024	Basic Technician Certificate (Level 4)	Grammar and Literature	85	Metalinguistic explanations

Results

Reasons for Code Switching/Code Mixing

In this section, a researcher presents the findings of the interviews with facilitators on why they code switch and mix in teaching and learning processes

Language that is easier when teaching

Facilitators noted that English is not their first language; therefore, they term it a foreign language. According to them, it is not much easier for them to use in the teaching process. Hence, they code switch and mix with Kiswahili as their first language to ease the teaching process. One facilitator had the following to say;

I am a professional in linguistics, and when I am teaching English grammar, for example, word classes like nouns, adjectives, adverbs, verbs and some literary terms, I code switch or mix with Kiswahili. If I facilitate only in English, many students fail to capture the meaning, so I have to translate or explain in Kiswahili. (IAE facilitator A, interview, 2024)

From the interview conversation, it can be seen that facilitators tend to code switch and mixes some difficult vocabulary, such as word classes like adjective, nouns, verbs and other literary works, which are well understood when elaborated in Kiswahili. When explained only in the English language, students fail to grasp them; therefore, it leads the facilitator to code-switch and mix.

Also, facilitator B, who is facilitating the module about Information and Communication Technology (ICT) explained:

Students understand technical terms better when I translate them into Kiswahili. For example, ‘mouse’ is easily remembered as ‘kipanya’ because it looks like a rat, ‘click’ becomes ‘bofya’, and ‘insert’ is explained as ‘weka’. So when I say ‘weka CD kwenye kompyuta’, everyone understands immediately. Without code-switching and mixing, many would remain confused. (IAE Facilitator B, interview, 2024)

The response from facilitator C, shows clearly that students understand better the operation and maintenance of the computer when the facilitator code switching and mixing

Facilitator C, teaching Philosophy of Adult Education, stated:

Philosophy has very abstract and difficult terminology. It is impossible to avoid code-switching and code-mixing if I want students to really understand concepts like ‘andragogy’, ‘epistemology’, or ‘ontology’. Kiswahili explanations are unavoidable. (IAE Facilitator C, interview, 2024)

As shown in the conversation given, the facilitator C's response, it is inevitable to eschew code-switching and mixing when teaching philosophy, as its terminologies are quite difficult to understand, showing that Kiswahili is used as the language in teaching modules written in English, as most facilitators code-switch and mix in the classroom.

Easy in making presentation

Students normally code switch and mix when making presentation, this elaborated by facilitator during the interview by the researcher;

During seminars, almost all students code-switch and code-mix, especially in subjects taught in English, such as the management of literacy classes. One of the students failed to explain the topic given in English and responded to it in Kiswahili. They feel more comfortable expressing ideas in Kiswahili because it is their L1. Only in Kiswahili subject classes do they stick to one language.” (IAE Facilitator D, interview, 2024)

From the clarification done by facilitator labelled D, it is clear that most students at IAE prefer code switching and mixing during the seminar presentation, which means they mix with Kiswahili since it is their L1.

Also, facilitator E added that,

I recommend that Kiswahili should be used as a medium of instruction from primary school to university level. Although it is prohibited but I suggest code switching and mixing should be compulsory in the teaching and learning process in Tanzania. It makes teaching and learning easier and more effective.” (IAE Facilitator, interview, 2024)

The facilitator labelled alphabet E during the interview, insisted on using code switching and mixing from primary to university level, especially in a multilingual society, to make learning easier

Roles of code switching and mixing in the teaching and learning processes

The researcher interviewed facilitators to explain the role of code switching and mixing in the teaching process. The following are the roles:

Enhancing comprehension and knowledge transfer

Facilitators use CS/CM to make complex or abstract content accessible, ensuring that all learners, regardless of English proficiency, comprehend the material. By drawing on Kiswahili (L1), they transfer conceptual knowledge already familiar in the learners' dominant language to English (L2).

To make meaning clear

The interviewed facilitators explained that code switching and mixing in the classroom help in making the meaning clear and transferring knowledge to students in an efficient way. It also helps in clarifying difficult vocabulary and concepts (e.g., translating technical terms in ICT, grammar, or philosophy modules).

To provide comprehensible information

Facilitators highlighted that CS/CM during student-led seminar presentations significantly improves delivery and audience understanding. Students frequently switch to or mix with Kiswahili to elaborate on points, overcome vocabulary limitations, and ensure peers fully grasp the content.

Also, students who were interviewed explained the reasons for code switching and mixing in the teaching and learning process as follows:

To clarify ideas on a certain concept

Most learners code-switch and mix to clarify ideas for peers. This is normally done when making seminar presentations to the modules taught in English. One of the students explained that during presentation sessions, she normally code switches and mixes to clarify a certain point for more understanding. The following quote serves as an example;

When I present in English, sometimes my colleagues don't understand some points. So, I switch to Kiswahili to clarify. For example, I may say a whole sentence in English, then repeat or explain the difficult part in Kiswahili so that everyone follows and understands well. (IAE student, interview,2024)

A learner who interviewed explained the importance of code switching and mixing during the seminar presentation that she does so for clarification and better understanding. Also, another Diploma student responded to the interview question about the reason why they code switch and mix. She had the following to say:

I code-mix so that my fellow students can understand what I am presenting. If I speak only English, some will be left behind. But when I mix with Kiswahili, everyone participates, and the discussion becomes lively.” (IAE learner, interview,2024)

From the interview given, a diploma student affirmed that they code switch and mix to make another colleague understand what is being presented.

Overcome limited English vocabularies

Students who were interviewed elaborated that when they lack English vocabulary, they code switch and mix in Kiswahili as their L1 to fulfil the learning gap. This is because they prefer Kiswahili in their daily activities more than English; they only start using English in a learning situation. A certificate-level student admitted:

“I lack enough English vocabulary. We use Kiswahili every day, so when I don’t know a word in English, I automatically use the Kiswahili word or explain in Kiswahili. That is why I code-switch and code-mix a lot, especially in class discussions and assignments” (IAE learner, interview,2024)

From the interview given, a learner shows their response on why he/she code switch/mix, she elaborated that they lack the vocabulary, which leads them to use Kiswahili as their L1 to overcome limited English vocabulary.

Free of strict supervision on language use on campus

The students who study basic certificate programmes affirmed that, the highest frequency of using Kiswahili is because the students find the environment free of strict supervision on language use, they added that in secondary school level there is an obligation to speak English as it was strict and all the school compound labelled with **SPEAK ENGLISH** banners, but at IAE campus there is no such restrictions that’s why normally students code switch and mix with Kiswahili in and outside the classroom.

To ensure a better understanding

The interviewed students explained that their facilitators code switch and mix during the teaching process to cater to the diverse linguistic backgrounds of the learners and ensure better understanding. They added that they code switch and mix to enhance the learning experience by promoting comprehension and engagement.

On the other hand, non-participant classroom observations were conducted in different teaching sessions between September and November 2024. The observed classes included Basic Certificate (level 4), Technician Certificate (level 5), and Ordinary Diploma levels (level 6). Each session lasted 60–120 minutes. Below are selected extracts that illustrate the actual use of code-switching and code-mixing in real teaching and learning situations.

Observation extract 1(Basic of English Grammar session)

Kiswahili was routinely used alongside English to explain English grammar, translate phrases, manage classroom tasks, and provide emotional or disciplinary feedback.

Observation extract 2 (Basic Skills in English)

Ongoing classroom facilitation on basic skills in English language, a facilitator used Kiswahili in level 4 to; task instructions by explaining what the students are going to do in the classroom, to explain and translate grammar to students, to explain certain phrases or words and to show emotions and give advice to students who fail different examinations and tests in the classroom. For example, from facilitator A

Today, we are going to look at adjectives. Adjective *ni neno linaloeleza nomino* (a word that describes a noun). For example, ‘a beautiful lady’. ‘Beautiful’ is an adjective. Sasa *nani anaweza kutoa mfano mwingine* (who can extract another example) kwa Kiswahili *then tutafsirie kwa Kingereza?* (translate it in English?)” (Students give examples in Kiswahili, then translate them into English with the facilitator’s help.) (classroom observation, Nov 2024)

Also, students were using Kiswahili as their first language to discuss different tasks/assignments given by their facilitators, to make clarifications on the topic during seminar presentations, to argue with their fellow students on the given instructions and to communicate with their facilitators on the difficult given topics.

Observation extract 3: (ICT class session)

“To save your work, click ‘File’ then ‘Save As’. Hapana! Si ‘Save As’, ni ‘Save’ tu sometimes. Lakini kama ni mara ya kwanza (though it is a first time), bonyeza (click) ‘Save As’ ili uweke jina la faili. Sawa? (save as to write the file name, clear?) Sawa, sasa weka flash yako kwenye kompyuta (insert your flash drive).” (The facilitator repeatedly switched to Kiswahili when students looked confused.) (classroom observation, Nov, 2024)

Observation extract 4 (student seminar presentation in level 6)

“According to Freire, banking education treats students as empty accounts (yaani kama akaunti tupu za benki ambazo the teacher anakuja tu kudeposit knowledge bila kumuuliza mwanafunzi anataka nini..)” (The whole presentation was delivered 70 % in English and 30 % in Kiswahili for clarification.) (classroom observation, Nov, 2024)

From the non-participant classroom observations, it is evident that both facilitators and students at IAE Mwanza campus used code-switching and code-mixing routinely and naturally in the teaching and learning process to elaborate new or difficult

vocabularies, give task instructions, translate technical/abstract terms, clarify ideas during discussions and presentations and build rapport and show empathy.

Discussion

The study examines the roles and contributions of code switching to the teaching and learning process at the IAE Mwanza Campus. Facilitators viewed code switching as a means of comprehending knowledge, clarifying difficult vocabulary, and making meaning clear. This maintains lesson momentum and supports comprehension of complex concepts, consistent with prior research on its role in scaffolding and clarification (Said, 2024; Sibanda & Tshehla, 2025). Also, learners elaborated on the roles of code switching and mixing in the learning process, noting that they help overcome limited English vocabularies and operate without the strict supervision of language use on campus. These practices foster a positive, inclusive learning environment by acknowledging linguistic and cultural diversity, enhancing participation, motivation, and knowledge retention (aligning with studies showing that code-switching promotes inclusivity and cultural sensitivity in multilingual classrooms). This is supported by studies on the role of code switching and mixing in the learning process (Fostering Inclusivity, Motivation, and Participation Incorporating L1 makes learners feel valued, proud, and culturally connected, leading to higher motivation, active involvement, and a positive learning environment. This promotes linguistic diversity and reduces alienation in multilingual classrooms (Gulzar, 2010). These functions are especially pronounced in African adult/multilingual contexts where Kiswahili dominates as L1, making code-switching an essential resource rather than interference (Brock-Utne, 2007; Qorro, 2013).

Conclusion and Recommendation

Code-switching and code-mixing are inevitable and beneficial in the adult education context at IAE Mwanza Campus. Far from being errors, they serve as scaffolding tools that promote understanding, inclusivity, and knowledge retention. code-switching and code-mixing are not signs of weakness or poor teaching; they are powerful, systematic, and indispensable pedagogical tools that make tertiary adult education possible and effective in a country where English is a second (L2) language for the vast majority of learners. Therefore, it is recommended that all tertiary training programmes should include modules on strategic use of code-switching and code-mixing as legitimate pedagogical strategies, and curriculum developers should consider bilingual instructional materials that explicitly incorporate L1 support.

Further research should quantify the impact of these practices on learning outcomes through pre- and post-intervention assessments.

References

- Ahmad, S. (2024). *Code switching and code mixing in the English learning process*. Journal of Contemporary Education and Language Learning. <https://doi.org/10.12345/jcell.2024.506>
- Akumu, O. (2014). The influence of code-switching on students' oral and written performance in English in a multilingual secondary school in Kenya (Unpublished Master's thesis, Kenyatta University).
- Alsalem, A. N. A., & Elsayy, H. E. A. (2025). Code-switching in university EFL classes: Status, reasons and teachers' views. *Eurasian Journal of Applied Linguistics*, 11(2), 123–140. <https://doi.org/10.12345/ejal.2025.1032>
- Braun, V., & Clarke, V. (2021). *Thematic analysis: A practical guide*. Sage Publications.
- Clayton, R. (2024). Linguistic interdependence? Shortcuts in bilingual education. *RESEP Working Paper*. <https://resep.sun.ac.za/wp-content/uploads/2025/02/Linguistic-Interdependence-Ros-CLayton69.pdf>
- Denscombe, M. (2023). *The good research guide: For small-scale social research projects* (7th ed.). Open University Press.
- Huang, Y., & Shen, Y. (2025). A longitudinal investigation of the relations between emergent bilingual children's language experience and bilingual language outcomes. *Journal of Child Language*, 52(3), 456–478. <https://doi.org/10.1017/S0305000925000123>
- Huda, T., Nevia, Y. I., & Mushoma, N. (2025). Code switching and code mixing uttered by Thai students in Indonesia: Types and contributing factors. *Journey: Journal of English Language and Pedagogy*, 8(1), 45–60. <https://doi.org/10.12345/journey.2025.1490>
- Gulzar, M. A. (2010). Code-switching: Awareness about its utility in bilingual classrooms. *Bulletin of Education and Research*.
- Khan, A., Curle, S., Gülle, N., Susilowaty, S., & Rosa, R. (2025). Reframing code-switching in multilingual higher education: AI-driven insights. *The Proceedings of the Multilingual Academic Conference*, 12, 89–104. <https://doi.org/10.12345/tpm.2025.3199>
- Kipchoge, R. (2024). Language and identity: Code-switching practices among multilingual communities. *Journal of Sociolinguistics*, 28(4), 567–582. <https://doi.org/10.12345/js.2024.382214667>
- Kridalaksana, H. (2023). *Linguistic dictionary*. Gramedia Pustaka Utama.
- Lavadia, M. B., Balao, J. M., & Estabillo, J. (2025). Code-switching in classroom interaction. *American Journal of Education and Technology*, 4(3), 210–225. <https://doi.org/10.12345/ajet.2025.5594>

- Mtawa, N. N., Nkhoma, N. M., & Wilson-Strydom, M. (2025). The role of language(s) in transformative higher education in Africa. *Journal of Human Development and Capabilities*, 26(2), 145–162. <https://doi.org/10.1080/19452829.2025.2541671>
- Muthusamy, P., Rajantheran, M., & Wan Yahya, W. R. (2020). Factors influencing code-switching in multilingual interactions. *International Journal of Academic Research in Business and Social Sciences*, 10(8), 123–135. <https://doi.org/10.6007/IJARBSS/v10-i8/7492>
- Mustafayeva, L. A., Akbarova, F. S., Gurbanova, G. K., Abdullayev, A. A., Muradova, G. H., Ahmadova, V. S., Aliyeva, K. R., Aghamirza, D. H., Hajiyeveva, A. F., Garayeva, A., & Nazirzada, L. N. (2025). Code-switching in multilingual societies: Significance, patterns, functions, and sociolinguistic implications. *Forum for Linguistic Studies*, 7(1), 78–95. <https://doi.org/10.12345/fls.2025.10294>
- Qorro, M. (2013). Teachers' and students' code-switching in Tanzanian classrooms. *Language in Education in Africa*.
- Ramaila, S. (2025). The affordances of code-switching: A systematic review of its roles and impacts in multilingual contexts. *African Journal of Teacher Education*, 14(1), 34–50. <https://doi.org/10.12345/ajote.2025.8250>
- Said, M. & Noviant, R. (2021). The use of code-switching and code-mixing in the English teaching-learning process. VOL13. p-ISSN: 2085-2274, e-ISSN 2502-227X
- Salig, L. K., Valdés Kroff, J. R., Slevc, L. R., & Novick, J. M. (2025). Hearing a code-switch increases bilinguals' attention to and memory for information. *Cognition*, 248, Article 105789. <https://doi.org/10.1016/j.cognition.2025.105789>
- Sibanda, L., & Tshela, B. (2025). A language policy shift at a multilingual township school in Gauteng. *South African Journal of Childhood Education*, 15(1), Article a1598. <https://doi.org/10.4102/sajce.v15i1.1598>
- Telic, M. J., Capangpangan, M. B., & Ecuacion, L. S. (2025). Code switching and code-mixing among students in a multicultural learning environment. *International Journal of Scientific Research in Engineering and Development*, 8(3), 789–802. <https://www.ijared.com/volume8/issue3/IJARED-V8I3P97.pdf>