Boston Research Journal of Social Sciences & Humanities

Volume 5 . Issue 9 . 2025
bostonresearch.org/brjssh

ENGLISH

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Online ISSN
2834-4863

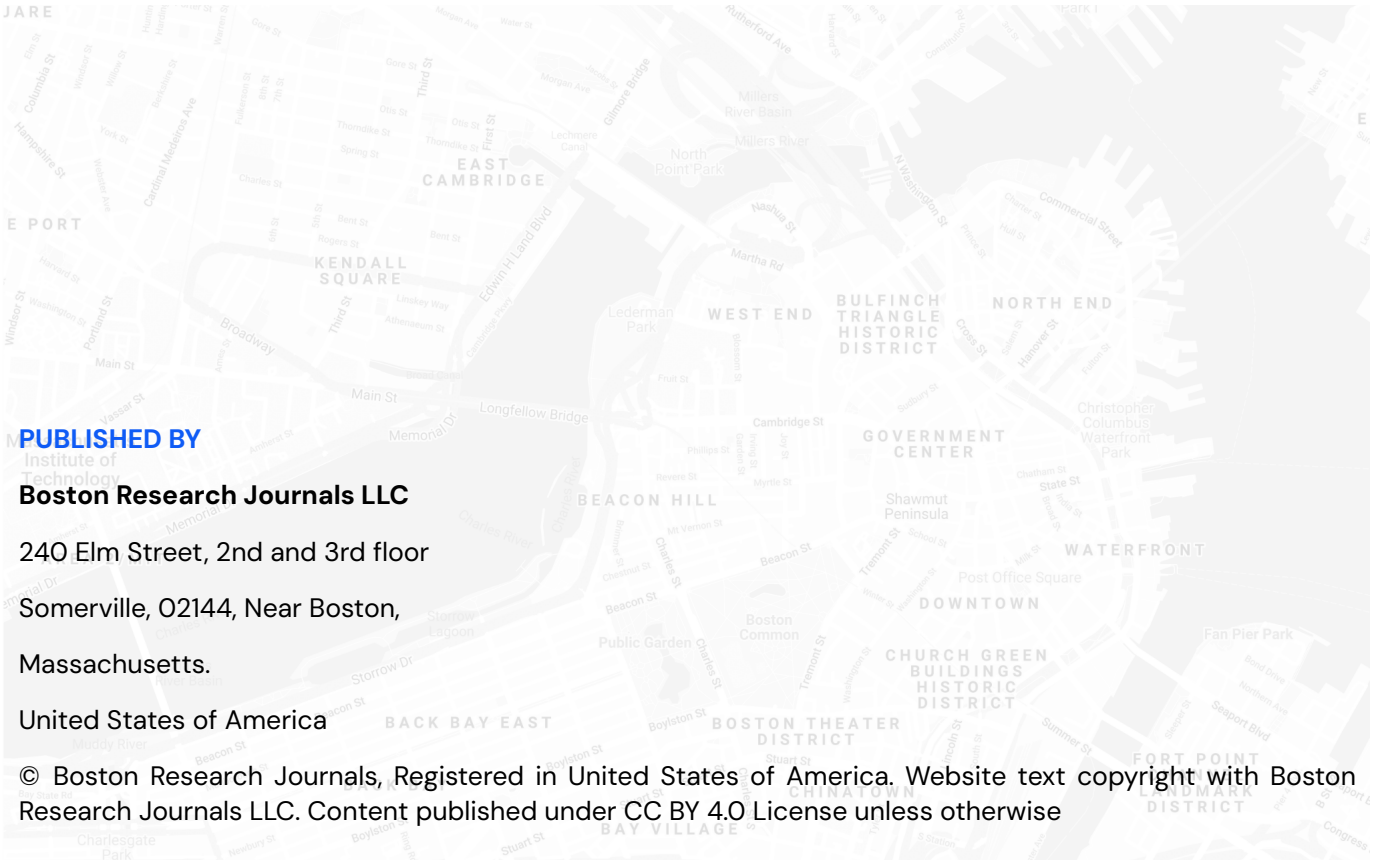
Print ISSN
2834-4855

Country of Origin
United States of America

Boston Research Journal of Social Sciences & Humanities

Empowering Research

Volume 5 . Issue 9 . Version 1 . MMXXV



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Preface

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RESEARCH ARTICLE BY BOSTON RESEARCH JOURNALS, UNITED STATES OF AMERICA

OPEN ACCESS

Assessing the Role of the Sierra Leone Teacher's Union in Nation Building: A Case Study of Sierra Leone Teacher's Union, Freetown

Alhaji Bakar Kamara[δ]

ABSTRACT

This article examines the pivotal role of the Sierra Leone Teacher's Union (SLTU) in the nation-building process of Sierra Leone. Through a mixed-methods approach, the study assesses the SLTU's contributions, challenges, and impact on the educational sector. Findings indicate that while the union is crucial for advocating teacher's welfare and influencing policy, its effectiveness is often hampered by political interference, poor working conditions, and internal challenges. The study concludes that a synergistic relationship between the government and the SLTU is essential for achieving quality education and sustainable national development.

Journal: Boston Research Journal of Social Sciences & Humanities
Keywords: Sierra Leone Teacher's Union, Nation Building, Education Policy, Teacher Welfare, Educational Reform, Sierra Leone.
Accepted: 29 October 2025
Published: 15 November 2025
ISSN: Online ISSN: 2834-4863 | Print ISSN: 2834-4855
Language: English
Research ID: 7dc1c588-13d1-423d-b333-924340e7bc20
Type: Peer-Reviewed Research Article (Open Access)

The authors declare that no competing interests exist. The authors contributed equally to this work.

Read Online: https://rebrand.ly/v0w1yq3

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I. INTRODUCTION

Education is the process of facilitating learning, the acquisition of knowledge, skills, values, and habits. It occurs through various methods—storytelling, discussion, teaching, training, and research—often under the guidance of educators, though self-education is also possible (Dewey, 1944). While its objectives are culturally

specific, a universal aim of education is to transform human behaviour—shaping how individuals think, feel, and act. The role of education in national development is paramount; it is essential for producing a modern, free nation by driving economic growth through a skilled workforce, fostering national unity, and underpinning political democracy with a literate, informed electorate (Hanson & Brenbeck, 1996, as cited in Gbamanja, 2002). Ultimately, education is a tool for empowerment, equipping individuals to meet future challenges and lead meaningful lives.

Within this educational landscape, teacher unions have become a formidable force, particularly in the public sector. For over a century, they have advocated for educators, though their efficacy and very legitimacy are constantly politically challenged. Often portrayed in media as militant and self-serving, unions have faced significant headwinds from federal policies like No Child Left Behind and Race to the Top, which have sought to curtail traditional collective bargaining power (Strunk & Grissom, 2010). In response, unions have adopted a spectrum of strategies, from defensive postures to proactive partnerships and independent reform initiatives.

1.1 The Positive Effects of Education

The value of education extends far beyond the classroom. Research consistently shows its profound impact on societal well-being (Cleveland, 2014):

A. Poverty Reduction: Education is a primary driver for escaping poverty. It provides the skills needed to secure employment and achieve self-sufficiency, breaking cycles of intergenerational deprivation.

B. Health Promotion: Educated individuals, particularly mothers, experience significantly better health outcomes. A child born to an educated mother is 50% more likely to survive past age five, and each additional year of a mother's schooling reduces child mortality by 2%. Education also acts as a "social vaccine," drastically reducing the risk of HIV/AIDS.

C. Gender Gap Closure: Education is a powerful tool for gender equity. It delays child marriage, empowers women to make informed life decisions, and leads to smaller, healthier families.

D. Malnutrition Minimisation: Educated populations are better equipped to fight hunger. Educated farmers adopt more effective techniques, and educating girls is identified as one of the most potent strategies to increase food security.

Economic Growth: There is a direct correlation between a nation's educational attainment and its economic prosperity. An educated workforce attracts investment, boosts productivity, and increases gross domestic product (GDP).

1.2 The Role of the Teacher

The teacher is the central agent in delivering these educational benefits. Teaching is a multifaceted profession requiring long hours and significant skill. Moore (1998) categorises the teacher's role into three primary functions:

A. Instructional Expert: Planning, guiding, and evaluating learning.

B. Manager: Structuring and maintaining an orderly learning environment.

C. Counsellor: Acting as a sensitive observer of student behaviour and a collaborator with parents, administrators, and colleagues.

A trained teacher is more than a subject-matter expert; they are an "educationist" versed in pedagogical principles, contemporary methodology, and an understanding of the learner (Gbamanja, 2004). In many jurisdictions, such as Sierra Leone, these roles are codified in official documents that emphasise efficient service delivery, commitment to the profession and community, and ethical use of resources (Kuyateh et al., 2009; UNICEF, 2009).

The role of the teacher is foundational to societal progress, acting as a catalyst for socialisation, change, and development across all facets of life (Saharan & Sethi, 2009). Teachers are the bridge and springboard for economic growth, stability, and national development. In Sierra Leone, the Sierra Leone Teachers' Union (SLTU) stands as the primary professional and trade union organisation tasked with safeguarding the welfare of teachers and, by extension, the quality of

education. This article assesses the SLTU's role in nation-building, using its headquarters in Kissy as a case study, to analyse its historical evolution, contributions, and the persistent challenges within the educational landscape.

1.3 Historical Context of the SLTU

The genesis of the SLTU dates back to the early 20th century, rooted in the dissent of Anglican Church School teachers dissatisfied with their conditions of service. This led to the formation of the Church School Teachers' Union (CSTU) in 1901. However, its scope was limited, excluding teachers in non-government-assisted schools and the protectorate (now the provinces). To amplify their voice, the Sierra Leone Protectorate Teachers Union was formed in 1964.

A significant milestone was the merger of these two entities in 1940, forming the Amalgamated Teachers' Organisation. Internal leadership struggles plagued the organisation until a historic special delegate conference in Bo in 1963 resolved these differences, leading to the birth of the Sierra Leone Teachers' Union (SLTU). Under the leadership of President Mr W.L. Sherman and Secretary General Mr Tamba E. Yambasu (appointed in 1966), the newly unified SLTU successfully pressured the government to pass the pivotal 1964 Education Act. Article 63 of this act mandated the creation of the Joint Committee for Teachers, a formal negotiating body for teachers' salaries and conditions of service.

The union's history is marked by periods of internal revolution, notably in 1980 and 1990, where mass protests over stagnant development and delayed salaries led to the overthrow of executive committees. These upheavals underscore the union's dynamic and often contentious role in advocating for its members (SLTU Annual Records, 2016-2020).

1.4 The Problem Statement

The Sierra Leonean educational system faces multifaceted challenges that impede the nation-building process. Teachers struggle with large class sizes and disruptive students, limiting their ability to provide individual attention and complete syllabi effectively, which negatively impacts overall student performance (Field Research, 2021).

A critical issue is the lack of parental involvement. Many parents, either due to demanding livelihoods or their own limited education, are unable to support their children's academic progress. This is compounded by societal issues, such as the need for a stronger focus on girls' education and changing deep-seated mindsets, as highlighted by the Minister of Social Welfare, Gender and Children's Affairs.

Furthermore, the SLTU itself grapples with a restrictive environment. The 1996 Collective Agreement remains the primary document protecting teachers' rights, yet the broader Education Act is perceived to limit the union's bargaining power. Instances of delayed salary approvals, leading to teachers working as volunteers, and tragic cases of non-payment of salaries—such as the documented female teacher who died in 2006/2007 while owed five months' pay—highlight the dire consequences of systemic neglect (SLTU Documentation).

1.5 Aim and Objectives

This study aims to assess the role of Sierra Leone Teacher's Union in nation-building. The objectives are as follows:

1. To assess the role of teachers as a pillar for national development.
2. To assess the role and responsibility of Teacher's Union in implementing national policy.
3. To outline prospective recommendations to the Government for supporting projects and activities of the Teacher's Union as partners in developing the nation.

1.6. Theoretical and Conceptual Framework

The theoretical underpinning of this study draws on the work of scholars who posit that teacher unions occupy a dual role: a trade union function focused on member welfare and a professional function aimed at educational improvement (Barber, 1996; Bascia, 1998). Barber (1996) argues that these two functions are intrinsically linked; the success of one depends on the other.

The conceptual framework defines core concepts:

A. Education is defined as "the training of people with a view to imparting intellectual or manual skills and the development of physical and moral qualities" (Page, 2001, as cited in Review of Educational Sector Analysis in Burkina Faso).

B. Quality Education, according to Fredriksson (2004, p. 4), is "the education that best fits the present and future needs of particular learners... and the community in question, given the particular circumstances and prospects."

C. Nation-Building is the process of constructing a national identity and unifying people within a state to ensure long-term political stability and viability.

This framework positions the SLTU as a crucial stakeholder responsible.

II. LITERATURE REVIEW: TEACHER UNIONS AND THE REFORM LANDSCAPE

2.1 How Teacher Unions Influence Education Policies

Teacher unions exert influence through two primary channels: collective bargaining and political advocacy. Scholar Terry Moe (2011, p. 275) argues that their political power may be "even more consequential" than their bargaining power. This power stems from their substantial resources—dues from a large membership—which are deployed to influence elections, lobby for favourable policies, and oppose reforms they perceive as harmful (Winkler, Scull, & Zeehandelaar, 2012). This influence extends to all levels of government, from local school boards to state legislatures and federal campaigns, allowing unions to shape the educational policy environment significantly (Hess & Leal, 2005; Lott & Kenny, 2013).

2.2 Educational Reform Without Teacher Unions

The past thirty years have seen a trend towards centralised, top-down educational reform initiated by state and national governments (Urban, 2004). This shift has emphasised standardised curricula, accountability measures, and mandates, often at the expense of local decision-making and capacity building (Bascia & Rottmann, 2011). Within this constrictive environment, teacher unions often find themselves marginalised. When their priorities align with policy, they are seen as compliant; when they oppose it, they are viewed as obstructions; and when they propose their own reforms, they are accused of overstepping (Bascia, 2003).

A central flashpoint in this conflict is collective bargaining. Critics argue that union contracts restrict administrative flexibility and inhibit reform (Strunk & Grissom, 2010). Policies like No Child Left Behind directly challenged bargaining agreements, for instance, by allowing for the removal of staff in persistently low-performing schools regardless of individual performance, clashing with standard "just cause" dismissal provisions in contracts (Krisbergh, 2005).

This has fuelled public antipathy, often amplified by media portrayals of unions as villains blocking progress (Goldstein, 2011). Documentaries like Waiting for "Superman" and studies linking unions to higher costs and lower performance have cemented this negative image in the public consciousness, fuelling support for reforms like vouchers and charter schools (Cooper & Sureau, 2008; Eberts, Hollenbeck, & Stone, 2004). Paradoxically, as these attacks have intensified, teacher unions have become increasingly the primary defenders of the public education system itself (Cooper & Sureau, 2008).

2.3 Teacher Unions' Reforms: Partnership and Independence

Contrary to their critics, a body of research depicts unions as active, committed participants in educational improvement (Bascia, 1994; Murray, 2004). Many have embraced "new unionism," a collaborative approach to bargaining that expands their role into professional and reform agendas (Urban, 2004).

A. Unions as Reform Partners: Many unions have formed partnerships with districts and states to drive change. Initiatives often focus on Peer Assistance and Review (PAR) programs, which mentor new teachers and intervene to support struggling experienced teachers, as seen in pioneering programs in Toledo and Seattle (Murray, 2004). Other collaborations have developed new evaluation systems (e.g., Pittsburgh's RISE program) and innovative professional development opportunities (Hamill, 2011).

B. Unions Reforming on Their Own:

Independently, unions often step in to fill systemic gaps. They provide professional development that states and districts do not, launch media campaigns to bolster support for public education (Bascia, 2008b), and even conduct their own research to inform policy (Bascia, 2003). They act as "test beds" for teacher-generated initiatives, from new curricula to student support programs, fostering bottom-up innovation (Bascia, 2000, 2009).

However, these partnerships are fragile. Their success often depends on the personalities of individual leaders rather than institutionalised practices, making them vulnerable to leadership changes (Johnson et al., 2007). Furthermore, collaborations can become unbalanced, forcing unions into accommodation rather than true partnership, especially on contentious issues like performance pay (Mead, 2006).

2.4 The "Good Union": Characteristics for Success

Successful, reform-minded unions share key organisational characteristics (Bascia, 2008a). They:

A. Articulate a Coherent Message: They develop a clear vision for a supported education system and consistently communicate it, rather than merely reacting to others' agendas.

B. Understand Costs and Benefits: They strategically assess the long- and short-term implications of partnerships and negotiated positions.

C. Address Member Diversity: They offer a wide range of participation and leadership opportunities to meet the varied needs of their membership.

D. Avoid Internal Fragmentation: They foster communication and coherence between internal departments (e.g., bargaining, professional development) that often operate in silos, sometimes at cross-purposes.

E. Exercise Leadership in Messaging: They avoid reactive, defensive language and instead work to shape a positive public discourse about teaching and teachers.

III. METHODOLOGY

This study employed a mixed-methods research design, utilising both qualitative and quantitative approaches to ensure comprehensive data collection and analysis (Gay, 1992).

A. Sample and Sampling: A simple random sampling technique was used to select 60 members from the SLTU headquarters in Kissy. Due to constraints, 50 members responded, representing a cross-section of the union's management and staff.

B. Data Collection: Primary data were gathered through structured questionnaires and personal interviews. Secondary data was sourced from published materials, including SLTU management reports, newsletters, annual records, academic journals, and online resources.

Data Analysis: The collected data was analysed using Participatory Action Research (PAR) and Total Socio-Economic Value (TSEV) concepts. Results were presented through descriptive statistics, tables, and charts for clarity and impact.

IV. ANALYSIS AND PRESENTATION OF DATA

This chapter focuses primarily on data analysis and discussion of the findings that the researcher has collected in the field of study. However, the analysis was conducted on both qualitative and quantitative methods, in which primary and secondary data were collected for discussions under review. Education is more than just curriculum and classrooms; it's the bedrock of a nation's future. At the centre of this vital system are two powerful forces: the individual teacher and the collective voice of their unions. This article explores their intertwined roles in shaping not only students but society itself. However, data analysis in this chapter is subdivided into the following headings based on the primary objectives of the study:

4.1 The Teacher's role: Architect for the future.

The profound role of a teacher as a nation builder cannot be overstated. They are far more than conduits of information; they are the

architects of character and the guardians of culture.

To fulfil this immense responsibility, educators must be lifelong learners themselves—constantly seeking knowledge, demonstrating strong character, and bringing creativity and innovation into their teaching. Through their perseverance, love, and sacrifice, teachers light the path that produces a nation's future leaders.

Their role is beautifully complex, blending the academic, the pedagogical, and the social. They are instructors, counsellors, and mentors (academic). They are motivators, evaluators, and facilitators of learning (pedagogical). Perhaps most importantly, they play crucial social roles: they are role models, confidants, surrogate parents, and guides who prepare students to participate fully in society.

A teacher's influence runs deep. Students are profoundly shaped by their teacher's compassion, integrity, and moral commitment. A respected teacher becomes a living example, their attitudes and ethics subtly woven into the fabric of their students' lives, especially during formative years when future plans are being made.

Ultimately, a civilisation is not built on abstract ideas alone; it is lived through the practical behaviour of its people. Teachers provide the vital link between concept and action. They create a learning environment pulsating with life, instilling in students a confidence in their culture, a respect for national values, and a strong moral compass. They help students stand firm on the foundations of tradition while reaching for new standards of academic excellence.

4.2 A Complicated Partnership: Teacher Unions and Educational Reform

The relationship between teacher unions and educational progress is nuanced. On one hand, organisations like the Sierra Leone Teachers Union (SLTU) play a direct role in systems that affect teacher quality and career progression.

However, a common critique, both historically and today, is that unions can become overly focused on the "bread and butter" issues—wages, benefits, and working conditions—sometimes at the expense of broader educational interests. Scholars like Bascia (1998) have noted this tendency, observing that such a focus can unfortunately alienate the very learners the system is meant to serve.

This isn't to say professional development is ignored. Unions do engage in efforts to broaden teachers' roles and capabilities. Yet, the tangible benefits of these initiatives for students can sometimes be slow to materialise.

Despite this tension, their role is indispensable. As Vaillant (2005) emphasises, the support of teacher unions is critical for successful educational reform. They are highly organised, well-resourced bodies that represent the people who implement policy daily: the teachers. No meaningful educational policy can succeed without their consultation and buy-in. They are, therefore, essential partners at the policy table, capable of championing real, positive change in the educational landscape.

4.3 What the Research Tells Us: Teachers Weigh In

Our research sought to understand teachers' own perceptions of their unions' roles. The results, drawn from high agreement scores, paint a clear picture:

A. A strong majority (73%) believes unions work to improve educational quality.

B. An overwhelming 83% agree that unions have professional responsibilities.

C. Most see unions as partners in policy-making (65%) and policy implementation (75%).

D. 71% believe unions are instrumental in ensuring schools function effectively.

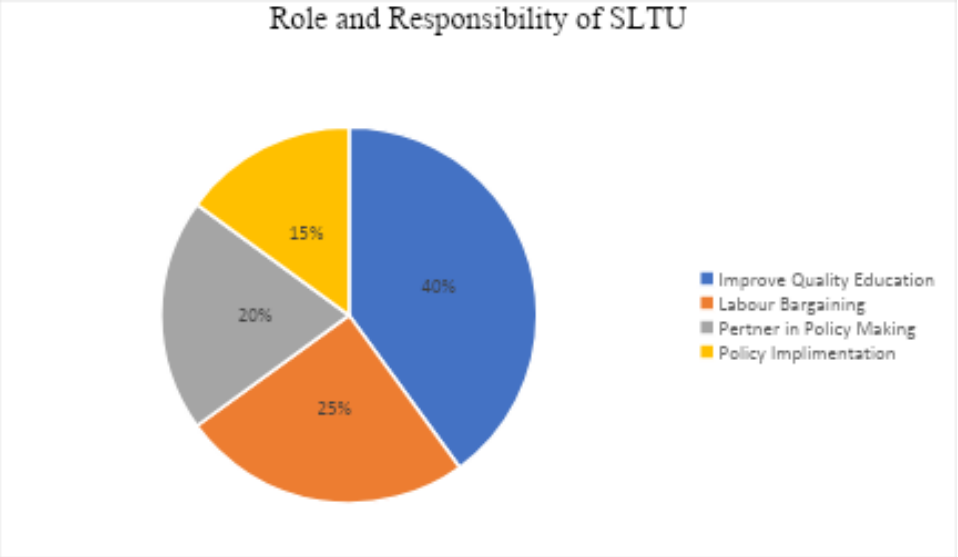
E. Yet, a significant 76% agree that a union's highest priority is protecting teacher rights.

This data aligns with the literature, confirming that unions are seen as contributors to quality education and professional matters. However, it also supports the idea that their activist energy is most visible—and perhaps most effective—when championing member rights, such as during salary disputes.

This creates a fascinating duality. While unions are recognised as facilitators of teaching and learning, their actions can sometimes contrast with this, such as when they resist the

implementation of specific policies like outcome-based education.

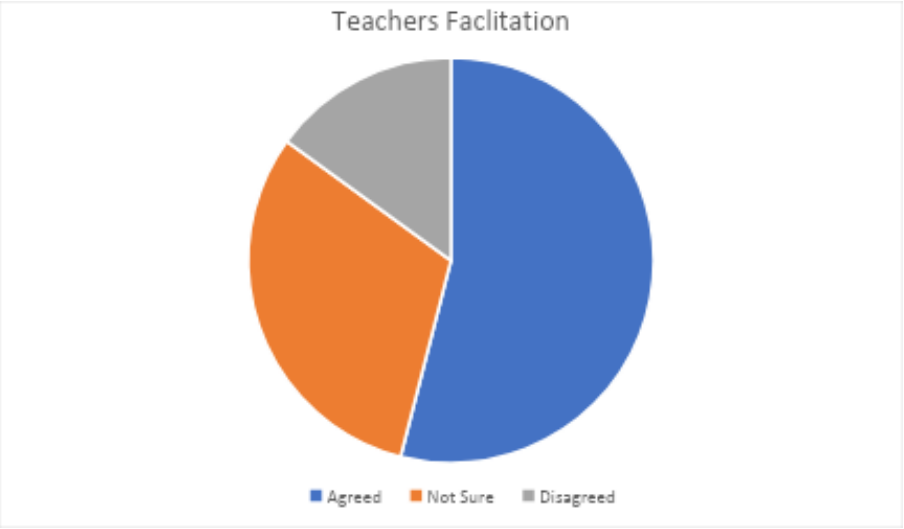
In essence, teachers primarily see their union membership as a form of protection—a vital shield in labour disputes. This practical need often defines the relationship more than any shared professional mission, highlighting the complex and sometimes conflicting realities of modern education system.



Source: Field Research, February, 2025

Figure 4.1: Shows the Role and Responsibilities of the Teacher's Union

The above table shows that 40% of the respondents agreed on the improvement of the quality of education, 25% of the respondents agreed on labour bargaining, while 20% of the respondents focus on the partner in policy making, and the balance 15% focus on the policy implementation.



Source: Field Research, February 2025

Figure 4.2: Shows the Teacher Facilitation

Teacher unions facilitate easy administration (Graph: E) of schools with 53% agreement, 36% disagreement, and 10% not being sure. The affirmation of the statement that teacher unions

facilitate the administration of schools is in line with the preceding paragraph, which states their wish to work in harmony with the SLTU in matters that affect teaching and learning.

In the interviews, SLTU indicated that their preoccupation was to bargain with the Ministry of Education in the interest of education in general and of their members in particular. They also indicated that they are engaged in collaborative efforts for the training of teachers in workshops with regard to curricula and policy matters. They indicated that they engage with the Department to allocate them money so that they could

4.4 Demographic Situation

The following are demographic variables that were considered during the research. They include gender distribution, age distribution, education, marital status, religion, and the establishment of a business.

4.5 Gender Distribution

The table below presents the sex distribution of respondents in the sample.

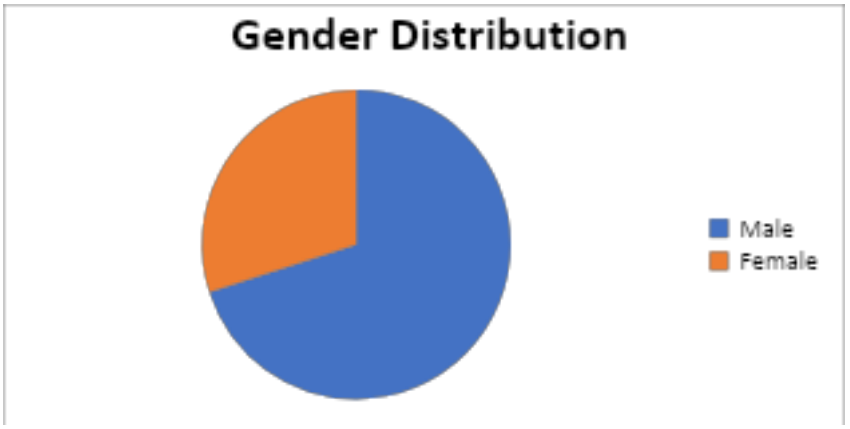
Table 4.1: Shows the gender percentage distribution of respondents in the study area.

Sex	No. of Respondents	Percentages
Male	35	70%
Female	15	30%
Total	50	100%

Source: Field Research, February 2025

From the above table, it is true that male respondents dominated the male respondents as interviewed in the study area. Few women were seen and interviewed at the administrative level of the SLTU in the sample size. It can also be noticed that more men were interviewed in the offices of the SLTU. Only 30% were women, and all 70% were men.

The information above is shown below in the form of a pie chart.



Source: Field Research, February 2025

Figure 4.3: Shows the gender distribution of respondents in the study area.

KEY

Male - 70%

Female - 30%

4.6 Age distribution of residents

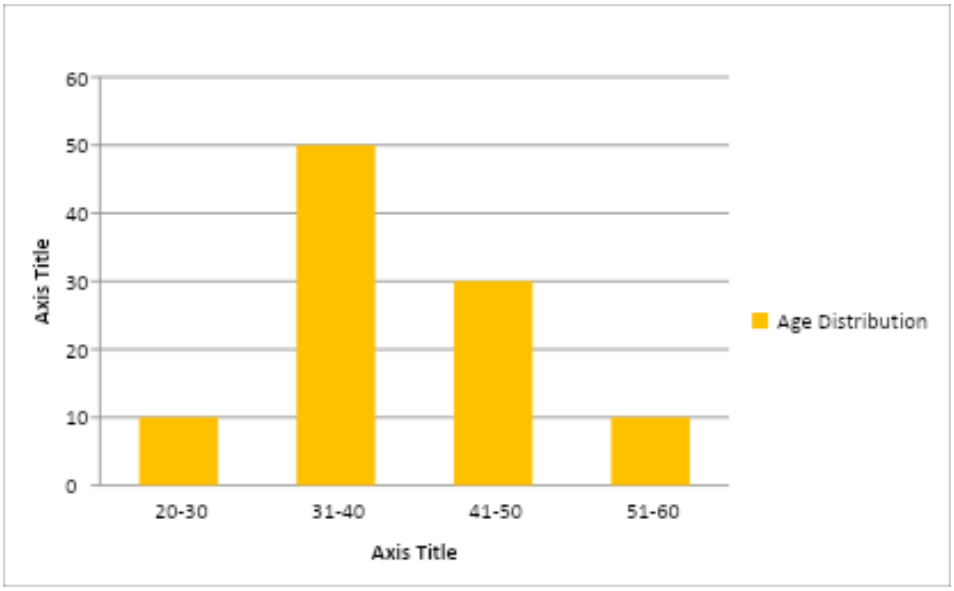
The table below shows the age distribution of the respondents in the form of age brackets, from 20 years to 60 years.

Age Bracket	No. Of Respondents	Percentage (%)
20 -------- 30	5	10%
31--------- 40	15	30%
41--------- 50	25	50%
51--------- 60	5	10%
Total	50	100%

Table 4.2: Shows the Age Distribution of Respondents in the study area.Source: Field Research, February 2025

The table above shows that 50% of the respondents fall within the age range of 41 to 50 years, while 30% respondents are in the age range of 31 to 40 years. 10% of the respondents fall within the age range of 20 to 30 years, also 10% of the respondents were found within the age range from 51 to 60 years.

The information is shown below in the form of a bar chart



Source: Field Research, February 2025

Figure 4.4: Shows the age distribution of the respondents in the study area

KEY

20 – 30 -10%
31—40 - 30%
41—50 - 50%
51—60 - 10%

4.7 The educational background

The table below shows the educational background of the respondents interviewed, as seen from primary to tertiary level of their background, and it was clearly shown in the form of percentages.

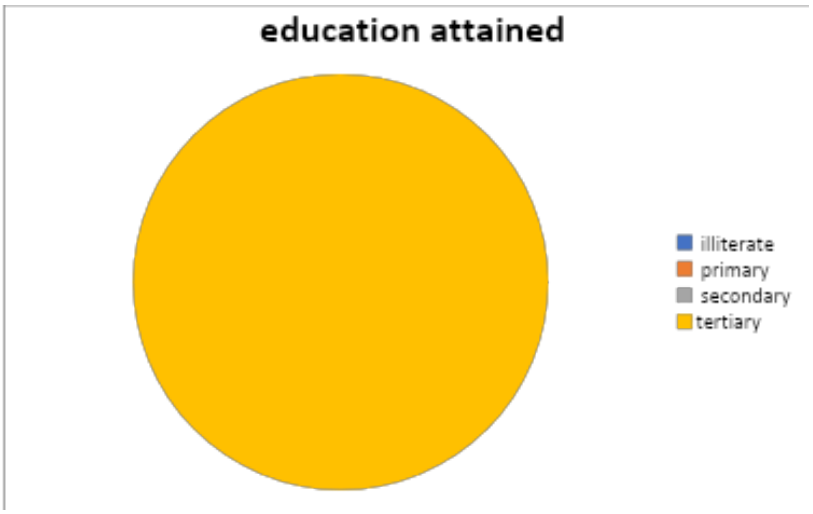
Table 4.3: Shows the Distribution of the Respondents According to the Education Attained

Educational Level	No. Of Respondents	Percentage (%)
Illiterate	-	0%
Primary Level	-	0%
Secondary Level	-	0%
Tertiary Level	50	100%
Total	50	100%

Source: Field Research, February 2025

From the table above, one can see that 100% of the respondents attained tertiary education, some attained degrees, while others attained teachers' certificates. It is seen that all of the respondents completed their tertiary education. A zero to illiterate and zero to primary education, and also to secondary education.

The following information is shown below in the form of a pie chart



Source: Field Research, February 2025.

Figure 4.5: Shows the percentage distribution of respondents' education attained

KEY

Illiterate -0%
Primary Level -0%
Secondary Level -0%
Tertiary Level -100%

4.8 The marital status

From the table below, one can know that because of the empowerment given to women to make their choices and decisions, the majority of them choose not to marry, and those who got married call for divorce as they feel.

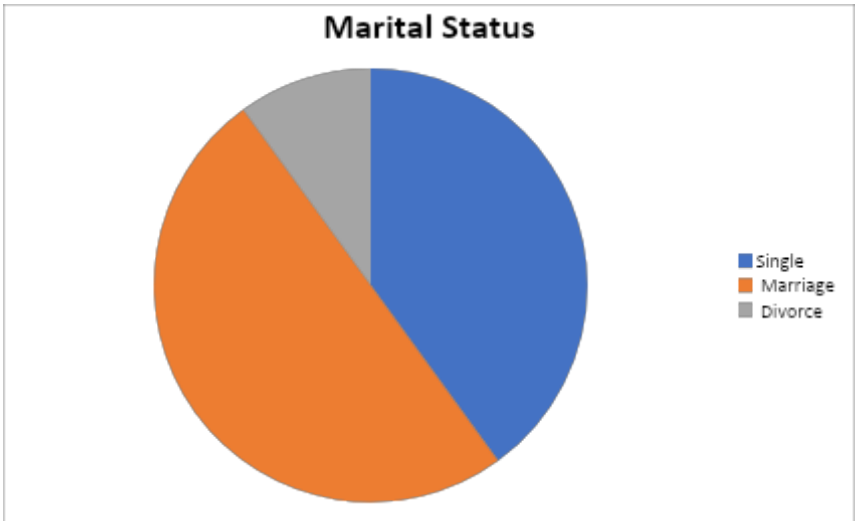
Table 4.4: Shows the percentage distribution of respondents according to marital status

Marital Status	No. Of Respondent	Percentage (%)
Single	25	50 %
Marriage	20	40 %
Divorce	5	10 %
Total	50	100 %

Source: Field Research, February 2025

The table above shows that 50 % of the respondents were single, while 40 % of the respondents were married, and 10 % of the respondents got married and divorced. Empowerment gives women the right to make their own decisions.

The above information is shown in a pie chart below.



Source: Field Research, February 2025.

Figure 4.6: Shows the percentage of respondents' marital status

KEY

Single = 40 %

Marriage = 50 %

Divorce = 10 %

4.9 Religious distribution

The table below shows the distribution of religion in the study area of the sample size, which the respondents complied with, the only two religions that are known within the country -Islam and Christianity.

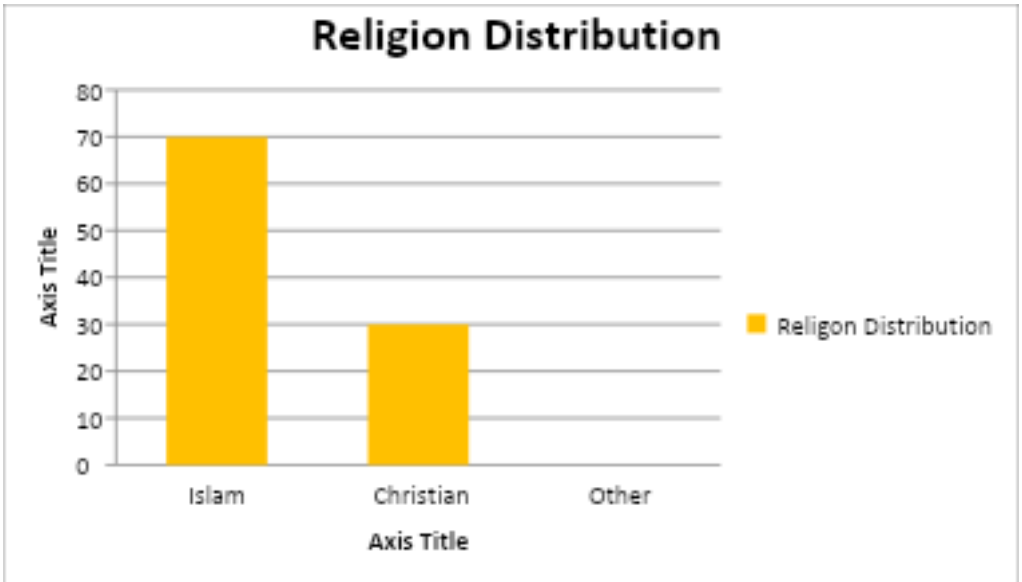
Table 4.5: Shows the percentage distribution of respondents' religion.

Religion	No. Of Respondents	Percentage
Islam	35	70%
Christianity	15	30%
Other	0	0%
Total	50	100%

Source: Field Research, February 2025.

From the table above, the reader can see that the majority of the respondents were Muslims. 70% of the respondents were Muslims, and the remaining 30 % were Christians. One can able to know that respondents don't recognise other religions, except Muslim and Christian.

The following information is shown in a bar chart below



Source: Field Research, February 2025.

Figure 4.7: Shows the percentage distribution of respondent's religion

KEY

Islam	-70%
Christianity	-30%
Other	-0%

4.10 Teacher's union role in the implementation of the national policy on education

The National Policy on Education (2004) reiterates that education cannot rise above the quality of its teachers. This statement no doubt emphasises the place of teachers in the realisation of educational objectives of every country, with particular reference to the developing countries like Sierra Leone, where functional education is mostly needed.

In view of the above, Nwite (2010) stated that the importance of teachers' unions as indispensable human resources and the single most important element in the school system should be recognised and given a prominent position in society. Also, Lassar, cited in Ofunsola and Deda (2007), referred to the teachers as the initiator of the learning process, the facilitator of the learning skills, the assessor of the learning sequence, the assessor of the learning efficiency, and indeed the pivotal element in the entire educational development.

Contributing to the roles of teachers' unions in the implementation of the National Policy on Education, Anikweze in Nwadum (2004) pointed out that it is the teacher who translates the educational policies into actions and principles and theories into real practices. He also argues that the decisions of the policy makers, no matter how coherent they may sound, the fashionable curriculum and the provision of adequate instructional materials notwithstanding, are all efforts in futility without adequate, qualified curriculum implementers that will facilitate the needed change in behaviour of the learners,

V. CONCLUSION AND RECOMMENDATIONS

The SLTU is an indispensable actor in the Sierra Leonean educational ecosystem and the nation-building project. While its historical struggle for teachers' rights is commendable, its potential is curtailed by systemic challenges, including inadequate funding, political interference, and poor working conditions. The effectiveness of any national education policy is contingent upon the will of political leaders and the capacity of motivated, well-supported teachers to implement it.

Based on the findings, the following recommendations are proposed:

A. Political Will and Funding: The government must demonstrate strong political commitment by increasing education funding and developing sustainable financial arrangements for the sector.

B. Capacity Building: The SLTU and NGOs should organise regular workshops and seminars to sensitise teachers on their roles and update their skills.

C. Merit-Based Recruitment: Recruitment into the teaching profession must be based on merit and qualification, moving away from catchment quotas and federal character systems.

D. Improved Dialogue: The Ministry of Education and the SLTU must foster a cordial, constructive relationship based on continuous dialogue and involvement in decision-making, not mere consultation.

E. Joint Training Programs: The Ministry and SLTU should collaborate on tailor-made training and mentoring programmes to build a dedicated and professional teaching corps.

F. Responsible Unionism: The SLTU must ensure that its advocacy strategies, including strikes, do not chronically disrupt teaching and learning, thereby safeguarding the quality of education.

In essence, nation-building is a collaborative endeavour. For Sierra Leone to thrive, its

government and teachers' union must work as partners, not adversaries, in the critical mission of educating its future leaders.

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RESEARCH ARTICLE BY BOSTON RESEARCH JOURNALS, UNITED STATES OF AMERICA

OPEN ACCESS

Concert and Ethnic Dance in Israel: A Century of Divergence and Convergence

Ruth Eshel

ABSTRACT

This article treats the Land of Israel as a cultural laboratory where ethnic, folk, and concert dance have cyclically diverged and converged. Tracing a century - from Ottoman rule and the Mandate through statehood and globalization - it follows early pioneers (Agadati, Nikova), Ausdruckstanz artists and holiday pageants, the post-1948 melting-pot government policy, and Sara Levi-Tanai's Inbal Dance Theater singular expansion of Yemenite sources. After an era of detachment (1960s–80s), rapprochement since the 1990s reflects pluralism and third-generation curiosity. Parallel Arab developments (dabkeh infrastructures, joint projects) and the Ethiopian-Israeli trajectory Eskesta Dance Troupe to Beta show how embodied micro-techniques can seed contemporary vocabularies. Recent examplars Orly Portal and Stav Struz-Boutrous, expand languages from within while interrogating gender, power, and identity. The article argues that Israeli dance models a plural modernity, where archives, pedagogy, and equitable collaboration sustain living traditions as engines for contemporary creation

Journal: Boston Research Journal of Social Sciences & Humanities
Keywords: Israeli dance, ethnic dance, concert dance, folk dance, cultural identity, globalization, holiday pageants, tradition and innovation
Accepted: 31 October 2025
Published: 15 November 2025
ISSN: Online ISSN: 2834-4863 | Print ISSN: 2834-4855
Language: English
Research ID: 222b23ca-8fca-4c9d-8800-39ecf5deb5d3
Type: Peer-Reviewed Research Article (Open Access)

The authors declare that no competing interests exist. The authors contributed equally to this work.

Read Online: https://rebrand.ly/nm61dak

I. INTRODUCTION

Building a new culture was part of realizing Zionism's aspiration to establish a national home on its historical land.[1] Many questions arose across all areas of life: should people speak and teach in Russian or German - the languages of immigrants before statehood - or revive Hebrew, the language of the Bible? What will people wear in the hot climate, so different from Europe, what music should they listen to, and what would they dance? The ambition was to create a Hebrew concert dance, a Hebrew folk dance and a Hebrew holiday pageant - genres that did not yet exist. This raised questions: from where would the new Hebrew dance draw inspiration? One source was the ethnic

dances brought by Jewish communities as they immigrated to the Land of Israel.

In this study, I seek to identify junctions of connection and divergence in concert dance, folk and holiday pageants over the past hundred years, reflecting the ideological, political, and social changes the state has undergone, as well as influences from the wider world.

II. WHAT IS "ETHNIC DANCE"?

The term "ethnic dance" is an umbrella under which gathers all dance expressions that serve the needs of a society whose members share genetic, linguistic, and cultural ties, with a special emphasis on cultural tradition. It is the widest base of dance within a given society, from which several types of branches out: ritual dance, folk dance, social dance, and concert dance (Bahat-Ratzon 2004:32). Folk dance, like ethnic dance, represents a specific cultural tradition, but places emphasis on the national element and a sense of belonging; it is the heritage of all strata of the people.[2] According to anthropologist and dance researcher Naomi Bahat-Ratzon, concert dance is positioned at the artistic apex of the pyramid. It is usually the product of an individual's creative initiative as a medium for personal expression, requires professional training to perform and is intended for presentation before an audience (Ibid: 49).

Bahat-Ratzon classifies ethnic dances in Israel into three main groups:

1. Group One - Dances characteristic of Diaspora communities that were danced in exile and whose traditions are preserved in Israel as well. Although ethnic dance is not closed and is subject to environmental influences, these communities maintained unique, characteristic dance traditions. Upon returning to Israel, they continued to dance their characteristic dances, despite changes necessitated by time and place. A distinctive community tradition of dance has been preserved among Yemenite Jews of Central Yemen and among some Hasidic groups.

2. Group Two - Dances of the countries in the Diaspora that were adopted by Jewish communities while living there. This group includes Jewish communities that dance the dances of the peoples among whom they lived. Once these dances were adopted by a Jewish community, they became identified with it internally and represented it externally. Included here are dances of Jews from Kurdistan; South and North Yemen; some communities from North Africa; Ethiopian Jews; Jewish communities in the Asiatic parts of Russia; and others.

3. Group Three - Dances of non-Jewish minority groups: Arabs, Bedouin, Druze, Circassians, and Armenians. In these groups we find ethnic dances characteristic of each group, which are largely like those of the same people in their countries of origin and in other diasporas (Ibid: 64-65).

III. FROM OTTOMAN RULE TO THE BRITISH MANDATE

The First Aliyah, or wave of immigration (1881–1904) to the Land of Israel took place under Ottoman rule, when most of the land then formed part of the province of Southern Syria. From the First Aliyah through the Third (1919–1924), we witnessed beginnings of cultural life in the New Jewish Yishuv,[3] but not concert dance. The pioneers of these waves came from Eastern Europe, Asia, and Yemen. They were mostly individuals - except for the Yemenite immigration, which arrived in families - idealists who went to establish agricultural settlements. There were no professional dance artists among them. At times, after a grueling workday, they danced the folk dances on which they had grown up in their lands of origin. Gradually, Hebrew words with new content were set to Russian tunes - songs still sung by Israelis today.

After World War I the Ottoman Empire collapsed, and the Land of Israel was entrusted to Britain as a mandate. The British chose to call it "Palestine," the name given by the Romans in 135 CE after suppressing the Bar Kokhba revolt.[4] The Romans changed the province's name from Judaea to Syria Palaestina in order to erase and prevent the historical connection. All the inhabitants under the British mandate were considered Palestinians - Arabs and Jews. With the end of World War I in the early 1920s, a wave of immigration arrived, mostly from Eastern Europe, from the Bolshevik Revolution and the civil war in Russia. This time, the immigration included families, industrialists, writers, and artists - including those destined to become the pioneers of Hebrew concert dance: foremost Baruch Agadati, Rina Nikova, and Deborah Bertonoff

from the Soviet Union; Dania Levin (Turkmenistan); Margalit Ornstein (Austria).

Agadati and Nikova believed one should turn to ethnic dance as a source of inspiration for creating concert works. Their decision was reinforced by the national struggles for independence in late-19th-century Europe - the "Spring of Nations." They turned to the small Yemenite community that had arrived on foot from Yemen as early as 1881, a community perceived as the continuation of Jewish history broken by exile 2,000 years earlier. Influenced by European Orientalism, they also turned to the local Arabs. Agadati and Nikova did not seek to create dance from "primordial existence" - i.e., authentic or traditional - rather, they sought a modern Hebrew concert dance inspired by the figures and movement language of Yemenites and Arabs.

Figure 1: Baruch Agadati in his solo dance "Yemenite Ecstasy" (c.1920). Unknown photographer. Courtesy of the Israeli Dance Archive, Beit Ariela, Tel Aviv.

Agadati also drew inspiration from Hasidic dance. This was surprising, since at that time there was a tendency to reject Diaspora culture to make room for a Hebrew culture. The choice stemmed from a search for movement language, not religious reasons. He explained: "The Jew is full of movement and does not speak without his hands, and when he dances, he wants to explain. The expression of this specific movement is my goal in dance" (Agadati, *Tzfira*, 19.7.1927). Agadati's varied background as a ballet dancer and an avantgarde painter found expression in his choreography and in the design of costumes and posters he created. His Hasidic-inspired dances and costumes were designed in a Constructivism style.[5] In the Yemenite-inspired works he was captivated by the delicate, inward, spiritual quality of movement that evoked Impressionist painting and danced with musical accompaniment, in silence.[6] Critic Deborah Rozolio wrote of the Yemenite-inspired dances: "These dances do not rely solely on external forms: they probe their inner content - subtle emotional compositions that he discovers and expresses in his magnificent body" (Rozolio, 1927: Press clipping). Among his works is a solo titled "The Arab from Jaffa." Usually rural types provided inspiration - especially shepherds, associated with biblical imagination that saw the Hebrews as shepherds with staff. Here, however, Agadati depicts an urban Arab figure that perhaps mirrors Agadati himself - dancing lightly on the border of effeminacy, always ready to pass from beauty to distortion.

Between 1922 and 1926, Agadati toured Europe. He saw himself as a Land-of-Israel dancer of Russian origin, performing exotic Hebrew dances of Yemenites, Arabs, and Hasidim with an avant-garde approach. In an article by journalist Uri Kesari, Agadati addressed European expectations: "It is interesting that everywhere I went I found great enthusiasm precisely among non-Jews. They love the specificity in my dances, the specificity in my expression, and this very specificity does not satisfy Jews, who would prefer to see in me a regular improvement upon European dances." (Kesari, *Doar Ha-Yom*, 13.2.1928).

Like Agadati, Rina Nikova's professional training was in classical ballet. She founded a company with young Yemenite women and sought "to show on the stage the splendid weave of our ancient history. It differs from Israeli dance [i.e., folk dance] in that it is more theatrical, more literary and decorative, and less purely movement based" (Interview with Nikova 30.11.1953). Her dances were situated in a romantic-pastoral atmosphere in nature; the return to nature was felt as an existential experience symbolizing the renewal of the Hebrew pioneer.

Figure 2: Nikova Biblical Ballet. "Work in Yemen" (c.1930). Photo: Ernst Kraus. Ruth Eshel Archive.

In 1937 the company sailed for a European tour. Europe was already infected by the spread of Nazism and Fascism; accordingly, they did not perform in Germany, Austria, or Italy, but did perform in Switzerland, Belgium, the Netherlands, England, Poland, Scandinavia, and the Baltic states. According to dance scholar Sari Elron, "Non-Jews described her more as 'Arab' and less as 'Hebrew'; the Jewish audience, by contrast, received the company as an authentic representative of the burgeoning Land-of-Israel culture" (Elron, 2022:17).

IV. THE RISE OF THE NAZIS

In the mid-1930s, following the Nazis' ascent to power in Europe, Jews fled, and some arrived in the Land of Israel (Palestine). Immigration from Central Europe brought dancers who had performed in leading Ausdruckstanz (German Dance of Expression) companies, including those of Vera Skoronel and Mary Wigman. These dancers esteemed the ethnic soloists who had toured Europe between the wars, and their repertoires included ethnic dances adapted for the stage. The popularity can be partly explained by the early-20th-century archaeological discoveries in ancient Egypt and Heinrich Schliemann's discoveries of ancient Troy, which fired the Western imagination; "the exotic" became a fashionable trend.

The dancers who arrived were proud to belong to Ausdruckstanz - a style in formation and considered avant-garde in its time. They believed

Ausdruckstanz provided a sufficiently open framework to convey universal ideas as well as national ones. Thus, Hebrew dance topics were often biblical yet expressed in the movement language of Ausdruckstanz. Gertrud Kraus - formerly Rudolf von Laban's assistant in Europe and a noted dancer-choreographer - created in Austria her suite "Ghetto Dances," drawing on Hasidic dance and Biblical subjects. Upon immigrating, she recognized the Orientalist stamp on those figures and rejected them. Instead, in 1935, she choreographed and danced "Impression of Eretz-Israeli Landscapes," a suite that was danced in silence and featured The Blessing of Dawn, Hamsin (heat wave form the desert), Tree Song, Stone, Twilight, Night, and Sun. These were minimalist dances, the essence of an expression. She said, "The Eretz-Israeliness of art is a tone, perhaps a color, or a ray of light skimming all. The artist absorbs from the land, created from its roots" (Kraus 1947: press clipping).

An exception among Ausdruckstanz artists was Yardena Cohen, born in the country, sixth generation on her father's side. In 1929 she went to Dresden and studied with Gret Palucca. Back home, Cohen regarded the Arab culture in which she was raised as a natural source for the creation of Bible dances, depicting biblical women in dramatic moments. Like her colleagues in the 1930s, she performed solo programs, yet her style sparked debate. Poet-critic Leah Goldberg wrote: "Yardena Cohen dances Eastern dance, but it is a photograph. We, Jews who rolled about for two thousand years in European lands, who heard Beethoven and saw Russian ballet, the companies of modern dancers from Isadora Duncan onward - is this really our feeling of the East? Can we react to our Hamsin [hot wind from the desert] exactly as some Bedouin woman does?" (Goldberg, *Davar*, 22.10.1937). However, theater critic Haim Gamzu, by contrast, addressed the modernist element he perceived in her work: "There is a special character to Yardena Cohen's dances: an identification with Eastern rhythm, a spiritual identification, not an imitation. Not for a moment does the viewer sense that a pure Eastern dance is before us. There are here the perfumes of the East - and something else. And that something else imposes a measured discipline, expressed in the secret of restraint in movement...." (Gamzu, 1939: Press clipping).

Figure 3: Yardena Cohen dances her solo "The Mourner" (1937). Photo: Hella Fernbach. Courtesy of the Israeli Dance Archive, Beit Ariela, Tel Aviv.

V. EXPRESSIONIST DANCE ARTISTS AND THE "HOLIDAY PAGEANTS"

Most pioneers who arrived were secular and needed new holidays and rituals to replace religious ones - frameworks that could unify internally and represent externally. Rudolf von Laban, the theoretician and guru of Ausdruckstanz, argued that one role of artists in this field was to create "movement choirs" in place of traditional folk dances. He staged mass spectacles on themes of trade unions for amateurs - works in the "spirit of the times" (Manor, 1978: 33).

The Land of Israel was a rare laboratory for his ideas: a small, isolated country yearning for original folk-dances and the revival of ancient agricultural festivals to express the pioneering renewal in the land, and Ausdruckstanzartists who had come from or studied in Central Europe with the ability to realize this vision. Thus, in the 1930s - 40s, drawing on Laban's ideas, concert dancers created the massehet (pageant in Hebrew) - a synthesis of movement, dance, text, and song. Pageants were staged under open skies; the holiday's content emerged from the site's historical context, with the topography itself serving as natural scenography. The dances interwoven into the pageants were designed for the pageant's directed performance; their creators saw them as artistic-ritual dances adapted to amateur performers. Land-of-Israel composers wrote music for these spoken-song-dance events. Occasionally such a dance became popular and crossed over - "seized by the people" from pageant and stage to become a true folk dance.

Figure 4: Members of Kibbutz Ramat Yohanan in the "Spring Omer Festival" procession to the special stage built in the fields, c.1940.

Unknown photographer. Courtesy of the Inter-Kibbutz Institute - Holidays/Festivals - Ramat Yohanan.

Figure 5: Leah Bergstein's "Spring Omer Festival" took place on a special stage built in the fields of Kibbutz Ramat Yohanan, c.1940. Unknown photographer. Courtesy of the Inter-Kibbutz Institute - Holidays/Festivals - Ramat Yohanan.

Among the leading creators were Lea Bergstein, who arrived from Austria and created the "Festival of Sheep Shearing," and the "Omer (harvest) festival" at Kibbutz Ramat Yohanan.[7] Yardena Cohen reconstructed at Kibbutz Sha'ar HaAmakim the biblical story of Yael and Sisera [*Book of Judges,* chapters 4-5] upon discovering it had occurred there. She took the event outdoors, to the original landscape, inviting all kibbutz members to participate and even neighbors from nearby Arab villages. Cohen wrote: "On the holiday, I asked a vendor from the Jezreel Valley to invite the nearby Arab village, perched on the hilltop, to celebrate with us. They even joined the light field feast in the courtyard. When they came, dressed in festive clothes with their wives and children to rejoice with us, I heard them say: 'By God, they are not Jews, but the Children of Israel…" (Cohen, 1963:50). In the "Water Festival," sprinklers played a role, as did shepherds moving in the background with their herds. Their model was adopted by most concert-dance creators, who also produced holiday pageants.[8] The 1940s saw the first attempts to create Israeli folk dance, thanks mainly to two immigrants from Europe, Gurit Kadman (neé Grete Lowenstein Kaufman) and Rivka Shturman. From 1944 through 1958 there were five folk dance festivals at Kibbutz Dalia, located in the Galilee region, about 30 km southeast of Haifa. The festival aimed to bring together people working in folk dance, and holiday pageants such as Yardena Cohen, Lea Bergstein, Sara Levi-Tanai, Gurit Kadman and Rivka Shturman.

The first Dalia Festival 1944 symbolically and practically marked the beginning of the folk-dance movement as an institutionalized movement under national governing bodies, foremost among them the Histadrut – General Organization of Workers in the Land of Israel (Roginsky 2004: 25). Because the Dalia festival occurred shortly after World War II and many thought it was not a time for a dance celebration. However, Gurit- Kadman who organized the first Dalia Festival "decided to hold the festival in spite of the unfathomable tragedy and suffering, the events embodied defiance: They showcased the new Jewish body and epitomized Hebrew strength precisely at a time when Jews were being annihilated" (Spigel 2013:135).

The idea of creating a folk dance, like the idea of creating a concert dance, sparked debates both for and against. Critic Leah Goldberg addressed this issue: "They showed [Dalia 1944] the dances and with them the basic question was also shown: the

question of the dance - of a nation in particular, and the question of folklore in general - is it possible to create folk art not in a natural-historical path, but out of a wish and direct cultivation," (*Al HaMishmar*, 23.7.1944). But despite the debate on the matter, the Jews in the Yishuv wanted folk dances of their own. "'Dalia Madness' seemed to infect Tel Aviv like the other towns and villages. Nobody remembered anything quite like it," (*Palestine Pos*t, 22.6.1947).

The second Dalia Festival 1947 took place on the eve of the War of Independence. During this time of great political tension, and despite a British imposed curfew under which no one could travel after sunset, 25,000 people arrived - approximately 5 percent of the Jewish population. Whereas at the first Dalia Festival the debates revolved mainly around whether it was possible to create folk dances artificially and rapidly, at the 1947 festival the debates centered on the abundance of performances by concert dance artists and their contribution.

Figure 6: Dalia Festival 1947. "Harmonika" by Rivka Shturman. Unknown photographer. Courtesy of The Israeli Dance Archive at Beit Ariela, Tel-Aviv.

Figure 7: Dalia Festival 1947. "The Well" performed by students of the Mikveh-Israel Agricultural school. Unknown photographer. Courtesy of the Israeli Dance Archive, Beit Ariela, Tel Aviv.

In 1947, Gertrud Kraus opened the festival with her new dance "Davka" (in spite of it being in Hebrew) after hearing that her mother had been taken to a concentration camp. For her and the Yishuv, "Davka" meant that we will go on dancing, and go on living. In addition, Agadati performed his "Ora [awaken in Hebrew] Glililt" (1924) the first Hebrew folk-dance.[9] Dance and theatre critic Giora Manor states, "In the dance he is seen holding a shepherd; staff in his hand, in deep plié,, while raising his leg high, the bent knee and raised leg lending extra emphasis to the stamping typical of the Hora, an exaggeration not found in the dance as usually executed: (Manor, 1984:9). Yemenite women from Rina Nikova's dance troupe performed at the event and Yardena Cohen created a fisherman's dance and Ausdruckstanz dancer Elsa Dublon performed her folk dance "Ma-yim, Ma-yim" (water in Hebrew).[10]

Kadman's original intention was for the festival to showcase the accomplishments in the field of Israeli folk dance. However, once performances were transferred onto a formal stage, the folk dancers appeared as amateurs, and a process of intermingling with concert dance ensued. "Because folk and theatrical dance were created at the same time by many of the same people, who also shared several notions about source of authenticity, these two arenas overlapped. Yet each form simultaneously aimed to distinguish itself from the other and to establish its own character" (Spiegel 2013: 147).

There are several reasons why the Dalia Festivals ended after 1968. The festival form may have become less suited to the evolving tastes of dance audiences and practitioners, especially as concert dance and other modern dance trends gained dominance. In addition, the tradition and symbolic role once held by Dalia were, in later decades, taken up by newer dance festivals - most prominently the Karmiel Dance Festival, launched in 1987 (more later).

VI. STATEHOOD AND THE "MELTING POT" POLICY

World War II broke out in 1939. The country became culturally isolated and relied on its internal reservoir. While Ausdruckstanz collapsed in Europe and was rejected in many countries as identified with Nazi Germany, Ausdurckstanz concert dance in Eretz Israel/Palestine flourished. After the War, the European powers began divesting from their colonies in Asia, Africa, and the Middle East. The UN Partition Plan to divide the land into two states (Jewish and Arab) was adopted on November 29, 1947, with Jewish agreement. The British Mandate ended on May 15, 1948, and seven Arab armies invaded to destroy the nascent state. Israel's victory established new borders and also produced waves of refugees - Arab and Jewish. Arabs left - either voluntarily, confident of Arab armies' victory, or were expelled from their homes in the Land of Israel (an issue debated to this day). At the same time, Jews were expelled from all Arab and Muslim countries and arrived destitute. They came from enemy states, spoke their languages, and were shaped by their cultures. Whole communities arrived from Iraq, Yemen, Libya, Morocco, Iran, Tunisia, and Egypt. Holocaust survivors arrived from Europe's death camps after losing loved ones and property. Immigrants also came from the USA, South Africa, England, India, and even China. The number of newcomers exceeded that of the absorbing population.

The young state became a Tower of Babel - a mélange of cultures of Jews from across the globe. To address this, the government formulated a melting-pot policy, which argued against cultivating each community's heritage to create a shared core for all. From this core, it was hoped Israeli culture would emerge.

Gurit Kadman saw with alarm the imminent danger to ethnic heritages and feared it was immediate and acute. She was the prime mover behind encouraging, supporting, and advising members of different communities who sought to cultivate their heritage and characteristic dances. In the mass immigration period after statehood, she went out with cameras and recording devices - sometimes just days after a community's arrival - to document their dances in their original form. She worked alongside ethnomusicologist Dr. Esther Gerson-Kiwi, who recorded instrumental and vocal music of the communities, including Arabs, Druze, and Circassians. This rare material is housed in the Dance Library at Beit Ariela in Tel Aviv.

With statehood, Israel opened to the world. Ausdruckstanz was rejected, and in its place the American dance - Martha Graham's style - was embraced. This style offered Israeli concert dancers a codified movement lexicon, a method for training dancers, and a language for choreography.

The aspiration of Israel's dance community was to professionalize to a universal standard - to be "like America."

VII. INBAL DANCE THEATER

Against this background, the development of Inbal Dance Theater was exceptional. Sara Levy-Tanai was born into a Yemenite family, orphaned young, and raised in a youth village on the foundations of European culture. At forty, seeking to tap her creative force, she gathered young Yemenite women and formed the Oriental Troupe. In an interview to dancer and researcher Judith Brin-Ingber, Levi-Tanai said: "The yellow desert landscape, the capricious climate, the vision of the dunes next to the sea, the veils of sand that are carried by the southeast winds, the camels' steps, their proud necks held high, their bells ringing, the horses' galloping hoofs all influenced me. The ecstasy of the song of the Jewish pioneers who were my first teachers, and their wild dancing in the nights, all nurtured the worlds of my childhood and were the sources that awoke my spirit and body to urge me to create" (In Brin -Ingber, editor, 2011:29).

In 1951, American choreographer Jerome Robbins visited Israel, was captivated by the dark-skinned Jewish dancers and an unfamiliar movement language - and upon his recommendation, the Israel Foundation Fund began to support the Oriental Troupe, which became Inbal Dance Theater, the first supported professional company. He also recruited American choreographer-dancer Anna Sokolow to come to Israel and train the company.

Figure 8: Inbal Dance Theatre. "A Psalm of David" (1963) by Sara Levi-Tanai. Dancers: Lea Avraham and Zion Nuriel. Photo: Mula Eshet. Courtesy of the Israeli Dance Archive, Beit Ariela, Tel Aviv

Figure 9 : Inbal Dance Theatre. "Songs of Songs" (1982) by Sara Levi-Tanai. Upper row: Zion Nuriel, Tamar Salomi. Photo: Gerar Allon. Courtesy of the Israeli Dance Archive, Beit Ariela, Tel Aviv.

Levi-Tanai distinctiveness - compared with earlier artists who turned to Yemenite sources - lay in expanding the movement language from within, i.e., from the ethnic DNA, while distancing it from movement elements identified with other genres (Eshel in Rottenberg and Roginsky, 2015: 281). She deconstructed and recomposed movement materials characteristic of the ethnic dance of Yemenite Jews and created a rich lexicon for stage dance for her personal expression. The "Inbalit" language grew together with the repertoire; the body of works across years enabled ongoing development, with the dancers as partners in its construction.[11] From the late 1950s onward, Inbal toured extensively and enjoyed meteoric success. Paradoxically, this very success - representing Israel's dance abroad - intensified ambivalence at home. Pride in their achievements was coupled with discomfort that an ethnic troupe identified with a small, specific community represented Israeli dance overseas - precisely at a time when the young state sought to project unity rather than segmentation and multiculturalism.

Perhaps such sensitivities about representation would not have grown so charged had Inbal been just one among several Israeli companies touring abroad. But after statehood, Inbal was the first stage dance company to appear abroad.

After Levy-Tanai's retirement, Rina Sharet was appointed artistic director, followed by former soloists Margalit Oved and Ilana Cohen. They created works for the company, but no successor emerged with Levy-Tanai's choreographic genius to lead the company forward.

VIII. DETACHMENT AND THE CREATION OF "ISRAELI STAGE DANCE"

From the 1960s to the late 1980s - about three decades - concert dance and ethnic dance moved apart. Concert dance professionalized and toured the world - led by Batsheva, Bat-Dor, and Kibbutz Contemporary Dance Company. According to dance scholar Dan Ronen, for many professional dance figures ethnic dance and the communities' folk dances seemed tied to outdated worldviews of

nationalism - at odds with fashionable ideas of "artistic freedom," "the end of nationalism," "multiculturalism," etc (Ronen 2004: 78). While, in parallel, several ethnic folk ensembles were founded, seeking to represent the dance traditions they brought from their countries of origin.

If the professional companies showed little interest in ethnic and folk dances, the void was filled by a new form known as "Israeli Dance for the Stage" (Mahol Yisra'eli la-bama). Jhonatan Karmon, who studied dance with Gertrud Kraus and ballet with Mia Arbatova, developed in the 1950s a professional dance company, created stage-oriented folk style, combining basic elements of then-characteristic Israeli folk dance (steps, skips, runs, etc.) with movement components from ethnic dances of Israel's communities and ballet. It is likely that he was influenced by the Igor Moiseyev Dance Company, which was founded in 1937 in the Soviet Union. Scholar Anthony Shay: "He [Igor Moiseyev] greatly expanded and developed character dance to produce a folklorized dance style that was initially unique to the Moiseyev Dance Company, and subsequently many other companies, both inside and outside of the former Soviet Union, faithfully emulated it" (Shay 1999:43). In 1959 the Karmon Dance Company went on its first U.S. tour, achieved great success, and continued touring for many years. Karmon's company was perceived as a folk and ethnic-dance ensemble adapted for the stage - a kind of Israeli counterpart to the Soviet Moiseyev Company. Over time, generations of choreographers - mostly his students - developed this direction, which continues vigorously today.

Figure 10: Karmon Dance Company - Karmon Company Archive. Alon Schmidt Collection.

Seeking to bring flourishing concert dance together with Israeli folk and ethnic dances, Karmon and Tirza Hodes founded the Karmiel Dance Festival in 1988, which, in the eyes of many, was a continuation of the Dalia Festivals. For over a decade it combined folk ensembles, ethnic and minority dances, international folk groups, and troupes of children, youth, adults, and people with disabilities - together with concert dance companies from Israel and abroad. It was a successful formula that merged stage dance with a public that also dances. There were hopes that Karmiel - this meeting of audiences - would also generate a meeting of genres. "On the festival grounds they shared the same space, but each retained autonomy. The festival did not initiate or provide a framework for dialogue between the professional artistic field and others" (Ronen, 2004:80).

IX. FIRST SIGNS OF RAPPROCHEMENT

For the first time, in the early 1990s, we see several works by choreographers integrating ethnic elements into their contemporary creations. Reasons included: a domestic climate supporting pluralism; globalization - "the shrinking world" - which increased uniformity in economy, culture,

lifestyle, and consumption; and postmodern ideology encouraging the weaving and blending of cultures from any time and place.

Despite doomsday prophecies - and perhaps as a counter-reaction to the erosion of identities - there remained and even grew an understanding of citizens' responsibility to choose between preserving uniqueness and community on the one hand and joining globalization on the other. Thus, after three decades of disconnect, we can identify early signs of rapprochement.

A common trait among the choreographers discussed here is that all are veteran, recognized creators in contemporary dance who dared to turn to an ethnic source – each for their own reasons.

In 1990, 500 years after the expulsion of the Jews from Spain by the Inquisition, a festival in Israel encouraged several companies to create works on the theme. One outcome of the expulsion was the dispersal of the then largest and wealthiest Jewish center across Europe and the Mediterranean basin; some came to Jerusalem and settled there. To this day they speak Ladino, developed from medieval Spanish enriched with Hebrew, Aramaic, and words from the languages of their new lands. Choreographer Moshe Efrati, a former principal with Batsheva dance company and himself of Sephardi heritage, created "Camina Y Tourna" (1990), a dance about Jewish wandering and exile through the generations, interweaving scenes of Sephardi folkways - such as healing rituals recalling exorcism - proverbs, and dances. The hugely popular musical "Bustan Sfaradi" (Spanish Orchard) by Israel's fifth President Yitzhak Navon likewise is devoted - through story and dance -to the Sephardi community and is still staged today.

Figure 11: Moshe Efrati Dance Company - Kol Demama. "Camina-Y-Tourna" (1991) by Moshe Efrati. Dancers: Avital Cohen (above), left to right: Adi Baram, Orly Portal, and Tal Bet-Halachmi. Photo: Yoram Rubin. Courtesy of Moshe Efrati

The duo Liat Dror and Nir Ben-Gal represented the young Israeli dance of the early 1990s. They surprised by integrating Middle Eastern belly dance in "Inta Omri" (1994, the Arabic phrase means: 'you are my life'), and "Dance of Nothing" (1999). This was not in response to the global belly-dance trend but part of a genuine effort to integrate into the Middle East. "Inta Omri" opened with Dror in a modest black outfit, performing a belly-dance solo - an ode to the female pelvis/hips - soft, undulating movement: a kind of `Great Mother,` ever-present, threatening and radiating security. She danced with upturned eyes, as if to herself, inviting the audience to contemplate her inner landscape rather than consume her as a belly dancer; the moves were not alluring but defiant (Eshel 2017: 628). "Dance of Nothing" was presented in a large tent - a kind of life-ritual of a Middle Eastern tribe living in a desert encampment, baking cookies for guests. Over two hours, they dance, love, rest, and listen together to the mother's storytelling (Dror). There are no beginning, middle, and end - only a mantra-like undulation in the body and the time of baking trailing them; once the cookies were ready, they offered them to the audience. Later, Dror and Ben-Gal left Tel Aviv for Mitzpe Ramon in the desert to live simply and later opened a dance program in Sderot near Gaza.

Figure 12: The Liat Dror and Nir Ben Gal—the Company. "The Dance of Nothing" (1999) by Dror and Ben Gal. Photo: Vardi Kahana. Courtesy of Liat Dror and Nir Ben Gal.

Choreographer, singer, and playwright Barak Marshall is known for his bold, theatrical works that blend dance, music, and storytelling. Barak Marshall grew up in Los Angeles to a Yemenite mother (Margalit Oved, the ballerina of Inbal's original troupe) and an American Jewish father. He studied social theory and philosophy at Harvard University before turning to choreography. In 1994 he came to Israel after his mother was appointed Inbal's artistic director and began creating independently. The differences between American and Yemenite cultures - and the equal weight both held in his development - led him to create dances in which the fusion of identities feels natural. His works include Hasidic dance, Yemenite dance, folk motifs, pop, contemporary dance, humor, and theatricality. They comprise scenes with sharp transitions between cultures, times, and places, delivered via costumes and a collage-like musical world: Middle Eastern ethnic music, classical, Hasidic, opera, and more. Notable works include "Monger" (2008), and "Rooster" (2009), and "Wonderland" (2020). In an interview with scholar Yonat Rothman (Rothman 2009: 13-15), he describes the inner conflict from which the dances are born: on the one hand a sense of belonging to the country because of proximity to family in Israel, friends, and dancers; Israeli dancers, he says, are full of energy, with

warmth and humanity in their movement that helps him express himself. Marshall divides his time between Los Angeles - where he directs a successful company - and Israel. In late 2025 he was appointed artistic director of Inbal Dance Theater.

Figure 13: "Rooster" (2000), choreographed by Barak Marshall. Batsheva Dance Company. Left to right: Jasper Throp, Yaniv Nagar, Adi Slant, and Keren Malkit. Photo: Gadi Dagon. Courtesy of the Batsheva Dance Company Archive and the Israeli Dance Archive, Beit Ariela, Tel Aviv.

Dancer-choreographer Renana Raz explores Israeli identity and created "Kazueria" (Cassowaries) inspired by Druse Dabkeh.[12] Dance researcher Einav Rosenblit writes: "The women on Raz's stage appear stronger than the men. When their bodies adopt the energy of the masculine dabkeh, a feminine physical capacity is revealed that surpasses the customary masculine stomping of the original dance. The uncompromising physicality leaves the five dancers tired but smiling, towards the men who enter at the end and join them in a joint dabkeh that suddenly seems easy to perform. Raz dances the powers of the woman, who may be the stronger sex" (Rosenblit, 2009:12)

Figure 14: "Kazueria" (2009), choreographed by Renana Raz. Photo: Avi Natan

X. ARAB ETHNIC DANCE

After the Nakba (Catastrophe in Arabic)[13] , Israel's Arab population[14] was bereft of its cultural elite, cut off from its connections with Arab nations and cultural centers to which their eyes had turned - Egypt, Lebanon, and Damascus in Syria. The Israeli Arabs turned to preserve and develop folklore as part of a quest for national identity; "Dabkeh" became prominent. The Communist Party influenced the promotion of "Dabkeh" companies and ballet in the Arab population. This requires an explanation regarding ballet. The first Israeli Knesset (parliament) of 1949 included three Arab members. As in other lands around the world within the Soviet sphere of influence, local Arab Communist activists were invited to the USSR for continuing education. There they encountered ballet as a great art capable of expressing any idea, including socialist ones. They brought love of and respect for ballet home with them.

From the middle of the 1980s and during the 1990s there were dance classes at Kfar Yasif, Haifa, Shfar'am, Nazareth, and Jaffa, with some developing into dance centers where the following generations would grow up. Most of this was among Christian Arabs. By the late 1990s, Arab students were entering higher-education dance programs such as the Workshop at Kibbutz Ga'aton (home to Kibbutz Contemporary Dance Company), the Jerusalem Academy of Music and Dance, and the dance school at Seminar HaKibbutzim at Tel Aviv.Footnote 15 The first Arab-society dance company, founded in Haifa in 1979, was Salma. Founder-director Ferial Khashiboun developed her own style blending free expressive-dance style with Middle Eastern dances: Egyptian, Lebanese, Arab, and Palestinian. Her aim, she said, was to shape an innovative dance with cultural and social message (interview with Eshel, 7.7.2016). The first seeds of the Sawiya (together, in Arabic) dance School at Shfa'arm were sown at the beginning of the 1990s when Rotary Shfar'am found a large hall at Nazareth Nuns convent and invited Rita Wakim to teach ballet there. Towards the late 2000s, the director Rahiv Hadad, asked Shaul Gilad, who had been running the music and dance studio at the Beit She'an (Jordan river) Regional Council for 26 years, to direct the dance track at Sawiya for four years. The new generation of teachers included Sahar Damouni, Shaden Abu Elassal (Arab), Diti Tor and Rachel Efrat-Assaf (Jewish). In Nazareth, Wedad Atallah founded Al-Amal (Hope in Arabic), combining ballet, modern, and Oriental dance. Other teachers who founded companies include Irina Jamal (ballet and Eastern dance) and Rita Shukair Wakim (Eastern dance and flamenco).

Figure 15: Sawiya Dance School - Shfar'am, "State of Siege" (2012) by Sahar Damouni, Shaden Abu Elassal, Diti Tor, and Wassim Hair. Photo: Rula Nasir. Courtesy of Sahar Damouni.

A central figure is Rabeah Morkus, formerly a dancer with Kibbutz Contemporary Dance Company at Ga'aton, who in 2007 opened her own school in Kfar Yasif; her troupe blends contemporary dance with motifs from Oriental and Sufi dance. Some of her works address the Nakba, & her dance vocabulary is based on contemporary dance with Oriental motifs. In 2010, she presented her piece "Exodus and the Odyssey" at an international dance festival at Ramallah (The Palestinian Authority) & Jordan. Morkus established the first dance track in the Arab sector at the Notre Dance High School in the Christian village Mi'ilya, and she is one of the faculty in the theater at the Western Galilee College. Together with Sharon Ashkenazi and later Ilanit Tadmor, she formed Bridges Dance Group (2014), connecting Jewish and Arab youth through dance (Tadmor 1988).

Figure 16: "Sufi Dance" (2011), choreographed and performed by Rabeah Morkus. Courtesy of Rabeah Morkus.

In 1993 the Arab-Jewish Community Center was founded in Jaffa's Ajami neighborhood by the Tel Aviv Municipality in partnership with the LA Jewish community, to further coexistence and tolerance among the Arab and Jewish populations there. Its school and stage projects are created in partnership with Batsheva Dance Company and Israeli artists - prominently Yasmeen Godder. Sahar Damoni is a Palestinian Arab Christian dancer. She was born in Shfar'am and holds a Bachelor's in dance and Movement for Practicing Teachers from Kibbutzim College of Education. Her work engages deeply with themes of gender, identity, politics, and the body in the context of Palestinian/Arab society.

Figure 17: *"We Love Arabs"* (2014), choreographed by Hillel Kogan. Dancers: Adi Boutrous and Hillel Kogan. Photo: Gadi Dagon. Courtesy of Hillel Kogan.

Unlike in the past, when cooperating with Jews was considered betrayal in the eyes of the Palestinians, today there is a willingness to take part in choreographies by Israeli creators. There are also few joint Jewish-Arab stage projects, among them featuring Hillel Kogan's "We Love Arabs" with Adi Boutrous - an Arab Christian dancer - mixing dance, text, and humor to grapple with identity and politics in the Middle East. "Body Dance Place - Performance Encounters City" is an annual project conceived and directed by Neta Pulvermacher, in her capacity as Artistic Director of the Dance Ensemble of the Jerusalem Academy of Music and Dance. "Body Dance Place" is an eight-month research and creative process shared by Israeli and Palestinian artists (dancers, singers, dramaturgs, designers, and choreographers). Its central theme is the city of Jerusalem and its diverse communities. The process culminates each year in a series of site-specific performances that take place in a different public or historical site in Jerusalem. Neta Pulvermacher's aspiration is to bring the rival nations closer together.

XI. RENEWED CONVERGENCE

From the early 2000s, Israeli contemporary dance has blossomed. Whereas in the early 1990s only a few choreographers integrated ethnic dance - and, apart from Liat Dror, usually in a single work the situation has shifted: several artists now build an oeuvre consistently fusing contemporary dance with an ethnic source. I believe several factors are at play:

- A supportive pluralist spirit. Yossi Yona, former head of the Forum for Society and Culture, captured a supportive pluralist spirit: "We must give expression to pluralism while avoiding the cultivation of separatism and enmity. We can build here a society with a shared denominator if every citizen can define their identity as part of the Israeli collective that seeks to shed sectarian features, while also allowing them to define their collective identity within sub-communities."

- A growing interest of contemporary choreographers in original movement languages and finding one's own specific voice.

- According to Goren-Kadman there is a universal pattern among immigrant communities: the first generation remains rooted in the culture of origin; the second tends to shed ancestral traditions to integrate into the dominant modern culture; the third - already integrated - develops an ambivalent stance, including renewed curiosity about the grandparents' traditions (Goren-Kadman 2009: 15).

Ronen concludes, "Anyone engaged in folk dance and heritage preservation discovers forces -

perhaps as an antithesis to globalization and identity loss - working to preserve and revive cultural heritages and to continue creating in styles appropriate to the contemporary world" (2004: 79).

XII. DANCING SHOULDERS

Israel's residents looked on in amazement and pride on May 24–25, 1991, when over 24 hours dozens of Israeli planes flew to Addis Ababa and airlifted 15,000 members of the Ethiopian Jewish community - Operation Solomon. It was preceded by the secret Operation Moses in the early 1980s, when thousands of Jews fled Communist Ethiopia and crossed the Sudanese desert to points where Israeli planes waited. When the secret became known, the operation was cut short. The estimate is that 5,000 Jews lost their lives during Operation Moses..

That dream, of Ethiopian Jews (known as Falasha – strangers, or Beta Israel – house of Israel as they call themselves) was to immigrate to "Yerusalem" (Jerusalem, the Land of Israe]. The longing for Jerusalem, was passed on from father to son, and from generation to generation. Most of the Ethiopian Jews lived in North Ethiopia in small villages, situated in the middle of nature, and their small houses, made of mud and straw. There was no running water in the house and no electricity. All the people in the villages were Jews who preserved their Judaism devoutly over many years. Today, 2025, Israelis of Ethiopian origin number about 190,000.

That year, during Operation Solomon (1991), Gila Toledano, head of Israel's Dance Library, asked me to conduct an ethnographic study. The Ethiopian community - whose legend traces descent to King Solomon and the Queen of Sheba - intrigued me. I bought a video camera and toured the country's absorption caravan sites for Ethiopian and Russian immigrants,[15] depositing dozens of hours of documentation in the Dance Library at Beit-Ariela.

Most Ethiopian Jews came from the Gondar region (some from what is now Eritrea). They dance the Eskesta - "shoulder dances" - learned from the Amhara among whom they lived. Their distinctively Jewish component is their liturgy, sung in Ge'ez,[16] the ancient language predating Ethiopia's Christianization. Eskesta offers a rich world of shoulder motifs differing in rhythms, directions, and qualities. Shoulders move vertically and horizontally, in straight lines or half-circles (twist), symmetrically or asymmetrically. Basic movements are amplified by imaginary scales of displacement - like a map of stations for the shoulders. To intensify the shoulders, one can add upper-torso flexion forward and backward. The arms are passive, elbows bent to the sides, thumbs resting on the hip

Figure 18: Eskesta Dance Troupe. "Opus for Shoulders" (2001), choreographed by Ruth Eshel. Photo: Ofer Zvulun. Ruth Eshel Archive.

In late 1995 I founded the Eskesta Dance Theatre at the University of Haifa, then home to some 300 Ethiopian-origin students. The company worked there for a decade; later I founded Beta ("house" in Amharic) at the Neve Yosef Community Center - a neighborhood of immigrants from Ethiopia and the former Soviet Union.[17] My aim was to create a contemporary Ethiopian dance, to expand the language from within through the dancers' natural movement - steering clear of recognizable Western stage genres. The creative process relied on image-based instructions I gave and asked the dancers to improvise in silence to heighten inner listening.

Figure 19: Beta Dance Troupe. "What the Shoulders Remember" (2005) by Ruth Eshel. Left to right: Gilat Bayenne, Gila Betualin, and Dege Feder (front).

Photo: Reuven Eshel. Ruth Eshel Archive

In 2005 I transferred Beta's artistic direction to Dege [Levi] Feder, a former soloist in both companies. Dege was born in a village in north Ethiopia. When she was eight years old, she joined her big brothers, who were then twelve and fourteen to join Operation Moses. Her brothers were caught by the police, and put in prison, accused of treason. Dege succeeded to hide and later joined other Jews who were beginning the journey to cross the Sudan desert. "We traveled by foot, without shoes. We traveled only at night, without any light, in order not to be caught by local residents or the dangerous robbers who would wait to find opportunities along the way, and during the day we would stop hiding. At a certain point in the journey, we ran out of food and drink. We had to continue for several days without eating or drinking," (Feder in Jackson, Pappas and Shapiro-Phim 2022:175).

In Israel she studied Art at the University Haifa, where she joined Eskesta Dance Troupe and subsequently, she was part of the ensemble of dancers who, together with me, founded the Beta Dance Troupe. Today, although she is a well-known and esteemed artist, she faces difficulties: "My work cannot be labeled in a straightforward manner as 'contemporary dance' or 'Ethiopian dance,' as I straddle the boundary between the two. On the one hand, I was lucky to have been raised in Ethiopia, and absorbed the environment, in the way of life,

the character, the connection to nature, and the culture of Ethiopia, and on the other hand when I arrived in Israel I absorbed the modern way of life and the possibility of observing and learning about a variety of other cultures. My encounter with two worlds gave me creative freedom to think, and an ability to be inspired by all the worlds. From that richness, and over years of work, there developed in me a distinctive language of movement which is characteristic of both my cultures, and it identified with me" (Ibid 2022:188-189). Dege places emphasis on abstract compositions and movement language, and integrates in her dances both Ethiopian-origin dancers and Israeli "franjim" (light-skinned Israelis) who are enthusiastic to work with her.

Figure 20: "Jalo", choreographed and performed by Dege Feder. Photo: Dan Ben-Ari.

Dege Feder has received several awards, including the Minister of Aliyah (immigration) and Integration Prize for Outstanding Contribution and a prize for Original Contemporary Creation.

Orly Portal – "I Felt I Came Home"

Orly Portal is Israel's most prominent figure successfully integrating tribal and Moroccan folk traditions with contemporary dance. Shel grew up in Kiryat Shmona near the Syrian border, in a neighborhood of North-African immigrants. Portal experienced it as a Moroccan village frozen in time - surrounded by simple, family-oriented people living by the customs they carried from the Atlas Mountains.

As she grew up Portal went on to study at the Jerusalem Academy, trained in classical ballet and modern dance. She danced with Moshe Efrati's company, with Batsheva Ensemble, and performed contact-improvisation programs with choreographer Arye Burstein. Improvisation drew her away from classical/modern techniques toward exploring natural movement and intuitive flow rooted in inner bodily listening. She says: "I investigated possibilities in the hip joints, the connection of movement and breath, and the weight of the body and pelvis. I began discovering and exploring the water quality in the body [...] the body began to be experienced as a large vessel of water [...] relaxation, the deep percolation of the water into the floor and earth, and their oscillations during movement led me to deep physical and emotional experiences that surfaced repressed memories and ancient feelings" (Portal 2021: 13)

Figure 21: Orly Portal Dance Company. "Rabia" (2012), choreographed by Orly Portal. Photo: Alex apt. Courtesy of Orly Portal.

She began performing solo programs in 1996 with leading Israeli musicians turning to their Middle Eastern roots. Alongside empowering experiences, she also faced difficult moments when spectators expected "belly dancer" entertainment. In 2009, she founded the Orly Portal Dance Company. "I created what was natural to me - simple movements connected to ancient, rooted, tribal experiences that had dwelt for years in my body. I transmitted them to the dancers through many repetitions, as in the folk world where embodied learning is by repetition. Repetition enables the magic - through simplicity, efficiency, and precision" (Ibid). Over the years, Portal created a new movement language; her programs receive excellent reviews in Israel and abroad. In addition, she developed a teaching method called "The Pelvis - Orly Portal Method" (2025:63-67), has her own school and is a member of the teaching faculty at the Jerusalem Academy of Music and Dance where she teaches her own style.

Portal is also a laureate of Israel's highest heritage prize.

Stav Struz-Boutrous

On the prestigious stage of Sadler's Wells in London, Stav Struz-Boutros received first prize - the Bloom Prize - in The Rose International Dance Prize 2025, awarded to experienced choreographers who have forged bold, innovative styles. The judges' statement of reasons for granting the award: "Stav interpreted this dance with her own body in mind and also put these movements in conversation with female Georgian dance. She reflects on how this helped her create a new dance language for herself." In the competition, Struz created and danced a full-length program, the solo "Sepia," offering an inner view of a female Georgian warrior.

Born in 1990 to parents who immigrated from Georgia, Struz-Boutros recalls: "Georgian tradition was not present at home; it was displaced from the family geography, just as my grandfather's surname, Sapiashvili, was changed to Sapiro. What remains to me are the memory of his appearance - to which I return to absorb his physical and emotional presence - two traditional swords my grandmother passed to me and my sister, and a dance book on Georgian dance in Israel" (Struz-Boutros 2022: 8).

She trained at the Jerusalem Academy of Music and Dance, danced with Batsheva Ensemble, Batsheva Dance Company, and Inbal Pinto & Avshalom Pollak Dance Company. During the COVID-19 shutdown - when artistic activity dwindled - an urge surfaced to experience Georgian dance forms, leading her to research in her body

the cultures of the Caucasus and the USSR; she delved into films and archival videos of traditional dances.

With the artistic counsel of her husband, acclaimed dancer-choreographer Adi Boutrous, she created several programs marked by balance between traditional and contemporary, by minimalism, precision, and repetition - allowing the viewer to perceive movement's complexity and giving it time to be digested and breathed. Through improvisation, she expanded the language from the DNA of the traditional idiom, abstracting it from its rules into personal expression.

Her work pays close attention to actions such as handwork - thumbs, fists - foot stamps,, knee-gliding, rising and sliding on the toes. In traditional materials, roles are often gendered - powerful, warlike virtuosity for men; doll-like lightness for women. She crafts a movement space that blends these qualities and roles, dissolving old stereotypes about how men and women should appear and move.

Figure 22: "Sepia" choreographed and performed by Stav Struz-Boutrous. Photo: Zohar Ron.

She created "Sepia" in 2021, conceiving the stage as a battle space. The piece opens with traditional throat-singing in the Tuvan language (the Tuvans live in Russia, Mongolia, and China and speak a Siberian Turkic language); the music gathers and prepares the audience. On stage she wears a shimmering jumpsuit, a headscarf with two long braided extensions, and a fur cape symbolizing the Golden Fleece, which Greek myth places in Colchis in the Caucasus. Lanterns cast warm light, white fur rugs, a slender brown branch with small green leaves. "My grandfather's sword lies onstage throughout - a reminder of the pain of wars hovering over us. In Georgian culture, the sword is a masculine tool; only men carry it. Over time it became a status ornament. During the piece I hold it, bring it close to my body, pass it by my mouth and eyes, rest it on my crown, and finally cradle it wrapped in white cloth - quieting its power" (Ibid 2022: 9).

In the duet "Nomads" (2022), about wandering, she broadened her cultural range - Azerbaijan, Armenia, Chechnya, the USSR - forming the research base. The work offers an intimate view of a domestic sphere - longing, yearning, solace - of two women, who share the fate of nomadic life in an abandoned space. Struz-Boutous gravitates to music that stirs nostalgia and emotions, completing the choreographic imagery. The soundtracks include melodies from Chechnya, Armenia, the USSR, and Turkey, merging cultures into a musical mosaic. In

2025 she premiered "Farewells," another gem in her string of works.

XIII. CONCLUSION

The findings of this study indicate that political circumstances - such as wars (World War I, World War II, and the Israeli War of Independence) and political revolutions (the Russian Revolution and the Communist Revolution in Ethiopia) - exert a direct impact on immigration waves: the countries of origin, the timing of immigration, the immigrants' contribution to the receiving society, and the worldviews they introduced. These factors, in turn, influence the degree of convergence or divergence between concert dance and ethnic dance. When the genre of a specific concert dance attains international recognition and establishes a self-sufficient artistic system - including a distinct movement language and a codified pedagogical methodology (for example, Martha Graham's technique or Ausdruckstanz) the less interest it has in ethnic dance. Rudolf von Laban (the main Ausdruckstanz theoretician) encouraged concert dance artists to apply their knowledge toward the creation of a new folk dance form. This responded to the Yishuv's aspiration to create a Hebrew folk dance. Ausdruckstanz concert dance artists also took a major part in the effort to create new agricultural festivals (holiday pageants) that had been lost following the expulsion of the Jews from their land. Sociodemographic considerations and governmental policies may promote a "melting pot" ideology, wherein diverse ethnic communities are expected to relinquish particularistic identities in favor of a shared national culture. Nevertheless, such policies cannot suppress the artist's intrinsic need for cultural and personal expression rooted in their own heritage, as exemplified by Sara Levi-Tanai (Inbal Dance Theater). As some concert dance artists mature artistically and achieve professional recognition, they overcome apprehension about engaging with ethnicity to answer a specific idea of need, even if such engagements are episodic (as in the works of Moshe Efrati and Renana Raz). By contrast, contemporary concert dance artists motivated by a desire to situate themselves within a specific geographic and cultural landscape tend to incorporate ethnic elements not as isolated experiments but as a sustained artistic worldview (for instance, Liat Dror and Nir Ben-Gal). In the postmodern era, the pursuit in Israel after an original movement language capable of distinguishing one artist from another further legitimized the exploration of multiple ethnic movement vocabularies. Among third-generation immigrants (for instance, Orly Portal and Stav Struz-Boutrous), there is a discernible aspiration to reexamine and reconnect with ancestral roots. In the Israeli context, this tendency is manifested by contemporary dance artists who trained and performed with prestigious companies and subsequently turned toward uncovering what they perceive as their "authentic movement language." This emerging phenomenon in Israel merits continued scholarly attention and longitudinal investigation.

XIV. FOOTNOTES

1. In the Hebrew Bible, Zion first referred to a specific hill in Jerusalem. Later, it became synonymous with Jerusalem as a whole, and eventually with the entire Land of Israel
2. In her seminal 1969 essay "An Anthropologist Looks at Ballet as a Form of Ethnic Dance," Joann Kealiinohomoku argues that all dance is ethnic, since every movement style reflects the cultural, social, and historical context in which it developed. She challenges the distinction between "art" and "ethnic" dance, showing that even classical ballet expresses the values of European Christian culture - hierarchy, control, and idealized lightness. In her view, every dance form mirrors the culture to which it belongs.
3. The Yishuv (in Hebrew, meaning "settlement") is the term used to describe the organized Jewish community before the establishment of the State of Israel in 1948. The Old Yishuv refers to Jewish communities that had lived in the cities like Jerusalem, Safed, Tiberias, and Hebron, mostly religious and supported by donations from abroad. The New Yishuv refers to the modern waves of Jewish immigration (Aliyah) from the late 19th century onward, who came with Zionist or other national/ideological motivations.
4. After the destruction of the Second Temple in Jerusalem in 70 CE, Jewish life in Judea continued under Roman rule. The revolt was led by Simon Bar Kokhba. The consequences for the Jewish population were devastating. Jewish settlement in Judea was severely reduced, leading to a shift of Jewish life to the diaspora.
5. Constructivism – an abstract style in Russian art after World War I, which influenced experimental dance (and theatre) by replacing

conventional painted "flats" with three-dimensional stage sets built of timber, metal or glass and by the rostrums and other spatial structures.

6. Several modern dance creators experimented in dance independent of musical accompaniment. Mary Wigman often used only percussion in her dances. Agadati was more radical than most and danced without any acoustic accompaniment, which was so innovative it caused hostile reactions for his listeners in Tel Aviv to the point where it made him abandon dance altogether.
7. Kibbutz means "collective." In a kibbutz the income, and resources were shared equally. Housing, dining (communal dining halls), and education were often shared. Today, many kibbutzim have undergone privatization – members often earn individual salaries, though some communal elements remain.
8. Even today one can still see holiday pageant at Kibbutz Ramat Yohanan, and in a few other kibbutzim and moshavim
9. Agadati created the dance to a Moldavian melody. In Dalia 1947 Kadman changed it to a Hebrew melody.
10. The main source of water is the Sea of Galilee, but the rest of the land is dry. The inhabitants had to rely on digging wells. Every discovery of water was a reason to dance and sing.
11. See Henia Rottenberg: "The Inbalit Language: Sara Levi-Tanai Creations," 251-290. In Sara Levi-Tanai: a Life of Creation edited by Dina Roginsky and Henia Rottenberg.
12. Dabke is a traditional folk dance from the Levant. The name comes from the Arabic word for stamping.
13. The Nakba in Arabic, meaning "the catastrophe" refers to the mass displacement during the 1948 Arab-Israeli War, which followed the declaration of the State of Israel.
14. The Political changes caused changing definitions in Israel's Arab population. Under the Mandate, The British called both Jews and Arabs "Palestinians." After the establishment of the State of Israel, the Jews became Israelis while the Arabs, named Israeli Arabs. After the Oslo Accords (1993), the Israeli Arabs termed themselves Palestinians.
15. This program is an opportunity to transition from education workers to certified teachers in just one year, without disrupting their work routine or livelihood. The program is intended for dance teachers who are actively engaged in teaching.
16. At the same time as the immigration of Ethiopian Jews during Operation Solomon (1990), there were large waves of immigration of Jews from the former Soviet Union. Caravan camps were set up throughout Israel to house the newcomers. The Jews from the former Soviet Union brought with them ballet artists, who contributed to raising the standard of ballet in the country, as well as an audience of ballet enthusiasts.

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XVI. AUTHOR

Dr. Ruth Eshel has a rich background in performance and research in dance. Having danced and choreographed many multi-disciplinary solo recitals (1977 - 1987) she went on to establish the contemporary Ethiopian dance troupes, Eskesta (1995-2005) and Beta (2005). She is the founding editor of the periodical *Mahol Akhshav (Dance Today) – The Dance Magazine of Israel* (from 2000) and a dance critic for *Ha'aretz Daily* (from 1991-2017).

Dr. Eshel is the author of the book *Dance Spreads Its Wings - Israeli Concert Dance 1920-2010.* , Published by De Gruyter, December 2021 - English. She established the website *Israel Dance Diaries* (www.israeldance-diaries.com) that serves a platform for high-quality writing about dance and features dance in Israel. It includes *Israel Dance Annual* (1975-1990), I*srael Dance Quarterly* (1992-2000) and *Mahol Akhshav - Dance Today* (2000 and henceforth). Eshel is the author or prose historical novels T*he Underground Engineer* [2022, English] and *The King on his Way to Kaplan?*(2025). She received the Minister of Culture's Lifetime Achievement Award in Artistic Dance in 2012, EMI (Union of Israeli Artists) for Life Achievement in Dance (2018) and was named Honorary Fellow of the Jerusalem Academy of Music and Dance (2021) and Tel-Aviv prize for Life Achievement (2025).

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OPEN ACCESS

Evaluation of an Autonomous, Arts-Based Therapeutic Methodology (D.D.A.T.A.) in Adults with Intellectual Disabilities: A High-Power Pilot Functional Study

Ioannis Makris[δ]

ABSTRACT

The Differentiated Didactic Approach to the Arts (D.D.A.T.A.) is a unique, multimodal pedagogical and therapeutic model whose efficacy has been strongly supported through extensive clinical application to a cumulative sample of 512 individuals presenting with diverse developmental challenges. This exacting high-power pilot quasi-experimental study was designed to provide foundational validation for D.D.A.T.A., focusing specifically on its quantifiable impact on adaptive behaviour and functional motivation in adults aged 18 to 45 diagnosed with Intellectual Disabilities (ID). A cohort of 27 participants was non-randomly allocated to an Experimental Group (n=14), which received the music- and movement-centric protocol, and a Control Group (n=13). The experimental group achieved highly statistically significant outcomes ($p<.001$) coupled with exceptionally large effect sizes (Cohen's $d>2.3$) across the two primary functional domains: Adaptive Behaviour (VABS Screener) and Motivation (MAS). Preliminary sensor data from the experimental group, generated by the method's integral sensor technology (S.T.E.A.M.), robustly reinforces the theoretical underpinnings by measuring a 78% reduction in rhythmic execution errors and enhanced accuracy by 4.8 standardised units. The integration of an autonomous Artificial Intelligence (AI) system is the next developmental phase, positioning D.D.A.T.A. as a future standard for personalised neuro-rehabilitation. Crucially, the D.D.A.T.A. protocol functions as a neuro-rehabilitative instrument, leveraging music's inherent capacity to induce measurable neuroplastic changes and motor synchronisation. This research provides compelling, robust empirical evidence from a high-power pilot trial, strongly justifying the necessity of a future large-scale Randomised Controlled Trial (RCT) and underscoring the urgent necessity of establishing a stable, dynamic institutional and research framework for its comprehensive technological and societal implementation.

Journal: Boston Research Journal of Social Sciences & Humanities
Keywords: D.D.A.T.A., Intellectual Disabilities (ID), Adaptive Behaviour, Motivation (MAS), Arts-Based Therapy, Neurorehabilitation, Artificial Intelligence (AI), Sensors, Functional Inclusion, Research Framework.
Accepted: 28 October 2025
Published: 15 November 2025
ISSN: Online ISSN: 2834-4863 | Print ISSN: 2834-4855
Language: English
Research ID: acd7a335-2eac-40cb-ac5c-97f9e4bafe91
Type: Peer-Reviewed Research Article (Open Access)

Read Online: https://rebrand.ly/pushvi4

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I. INTRODUCTION: THE IMPERATIVE FOR FUNCTIONAL AND AUTONOMOUS INTERVENTION

1.1 The Global Challenge of Sustained Functional Inclusion in Adulthood

The transition to adulthood presents significant and often seemingly insurmountable challenges for individuals diagnosed with Intellectual Disabilities (ID). While most early intervention initiatives prioritise foundational educational milestones, a pervasive and enduring gap remains in developing the functional independence and sophisticated social competencies essential for sustained employment, autonomous living, and genuine social integration (Brown, 2018). Traditional, passively received educational paradigms frequently prove insufficient in addressing the dynamic, personalised, and multi-sensory learning requirements of this population, often resulting in continued dependency and elevated rates of social marginalisation later in life. Addressing this critical functional deficit mandates novel, dynamic interventions fundamentally rooted in quantifiable practice, inherent motivation, and objectively measurable outcomes.

1.2 The Genesis and Scope of D.D.A.T.A. (2012-2020)

The Differentiated Didactic Approach to the Arts (D.D.A.T.A.) was conceived as a direct, comprehensive response to these limitations. Developed and pioneered by Dr. Ioannis Makris in Greece between 2012 and 2020, D.D.A.T.A. constitutes a dynamic cognitive-behavioral methodology that strategically employs Music, Dance, and Drama as the principal vehicles for therapeutic and developmental progression (Macri et al., 2019; Makris, 2020). Crucially, the methodology arose from the systematic synthesis and rigorous refinement of the author's extensive practical experience as a Special Educator within secondary special education structures. The methodology is primarily a music-centric intervention, harnessing the inherent structural and motivational power of rhythm and melody to scaffold and organize behavior and cognition. D.D.A.T.A. is predicated on continuous technological innovation and rigorous interdisciplinary research (Makris, 2015a; Makris & al, 2022). The method's scope extends beyond the conventional classroom setting, culminating in the establishment of inclusive artistic ensembles, such as the internationally recognised "Ichochroma" Orchestra, which serves as the ultimate benchmark for functional integration and collective success. Clinical observations meticulously gathered from the method's application to an accumulated sample exceeding 512 students since 2012 profoundly affirm the necessity of this multimodal, functional approach.

1.3 D.D.A.T.A. as a Neuro-rehabilitative Framework

D.D.A.T.A. must be conceptualised not merely as a pedagogical tool, but as a robust form of active neuro-rehabilitation. Rehabilitation, specifically within the context of ID, is defined by its aim to optimise the functional capacity of individuals experiencing cognitive and motor impairments (Buntinx & Schalock, 2010). The D.D.A.T.A. protocol achieves this by actively engaging participants in structured instrumental music performance and synchronised movement, activities that are well-established drivers of neuroplasticity (Koelsch, 2010). The required tasks demand the precise temporal synchronisation of auditory input, visual cues, and motor output, thereby effectively circumventing traditional cognitive processing barriers. The intervention directly targets the refinement of Gross and Fine Motor Skills, postural balance, and overall coordination, positioning it as a highly efficacious framework for physical and cognitive restoration and skill acquisition.

1.4 Research Objectives and Hypotheses

This pilot study was designed to rigorously evaluate the following hypotheses as a preliminary validation of the D.D.A.T.A. model in adults:

The D.D.A.T.A. intervention will yield a statistically significant increase in Adaptive Behaviour scores (VABS) within the experimental group compared to the control group.

The D.D.A.T.A. intervention will lead to a statistically significant improvement (reduction in scores) in Functional Motivation scores (MAS) within the experimental group compared to the control group.

The measured effects will exhibit large clinical importance (Cohen's $d \geq 0.8$), thereby validating D.D.A.T.A. as an autonomous, empirically effective therapeutic model (Buntinx & Schalock, 2010).

II. THEORETICAL AND EMPIRICAL FRAMEWORK

The Differentiated Didactic Approach to the Arts (D.D.A.T.A.) is a structured, multimodal pedagogical and therapeutic system founded upon specific psychophysiological and applied behavioural constructs designed to optimise functional capacity in individuals with Intellectual Disabilities (Makris 2020; Makris 2022; Makris 2024). The theoretical premise centres on the stimulus-response mechanism, asserting that a precise visual, auditory, or haptic stimulus from an individual elicits a corresponding, measurable psychophysiological response. Critically, the synchronised and structured aggregation of these responses among multiple participants leads to the formation of a cohesive therapeutic Gestalt or Ensemble, thereby enabling functional activation and the subsequent development of a broad spectrum of cognitive, social, and motor skills. This entire process is guided by the necessity of Adaptability, whereby the desired psychophysiological outcome is rigorously adjusted to the specific functional level and capacity of each individual. Operationally, D.D.A.T.A. is underpinned by five core principles: Individualisation, comprehensive Multisensory Learning, immediate Positive Reinforcement, therapeutic Collaboration, and the integral Integration of Technology (e.g., S.T.E.A.M. and future AI systems for objective measurement (Makris 2022; Makris 2024). The systematic application of the method is ensured via a detailed 13-step protocol, which spans from initial psychometric skill assessment and goal setting to work adaptation, strategic modelling, and continuous goal reassessment and evaluation.

2.1 Core Theoretical Pillars

The observed success of D.D.A.T.A. is predicated upon a cohesive, integrated application of cognitive, motor, and psychological theories:

A. Cognitive and Motor Models (The Centrality of Music): The Motor Model posits that physical motor action is integral to sustained cognitive development. D.D.A.T.A. leverages the inherent predictability and organisational structure of rhythm as an "internal clock" for the brain, furnishing essential temporal and spatial scaffolding for individuals facing executive function deficits. This is dynamically coupled with visual coding (Makris, 2017) and principles derived from Information Integration Theory (Anderson, 1981; 1991), where abstract musical concepts are meticulously translated into clear, real-time visual signals. This multi-sensory redundancy (auditory, visual, haptic input) significantly mitigates cognitive load (Mayer, 2013) and accelerates the formation of durable neural pathways crucial for complex skill execution.

B. Applied Behaviour Analysis (ABA) and Functional Assessment: Foundational ABA tenets, such as task analysis (the systematic decomposition of musical tasks) and shaping (Cooper et al., 2007; Heward, 2011), are strategically employed to facilitate the gradual development of complex musical skills. Crucially, the musical performance itself serves as a potent, immediate positive reinforcer (Krumboltz, 1983). Unlike abstract or delayed rewards, the instant auditory feedback generated by a successful musical passage, coupled with the social reinforcement inherent in ensemble membership, directly addresses the functional motivations identified by the Motivation Assessment Scale (MAS) (Durand & Crimmins, 1988).

C. Psychological Models: The methodology's adept management of participant engagement and motivation is structurally supported by Reversal Theory (Apter, 1989). Furthermore, D.D.A.T.A. is fundamentally congruent with the P.E.R.M.A. model of Positive Psychology

(Seligman, 2002; Makris, 2020; Seligman, 2018, 2019; Linley et al., 2006). The process of creating and performing inclusive artistic projects inherently fosters Positive Emotion, deep Engagement, and tangible Accomplishment, ultimately leading to enhanced Meaning and Relationships—factors critically important for self-actualisation.

2.2 Neuroscientific Foundations: Neuroplasticity and Embodied Cognition

- Music, Rhythm, and Cortical Reorganisation (The Sacks Perspective): Research, notably by Sacks (2007) and Koelsch (2010), firmly establishes music as one of the most powerful and sustained forms of neurological stimulation. The precise, highly structured rhythmic nature of the D.D.A.T.A. protocol actively promotes cortical reorganisation (Makris & Macri, 2003) by concurrently activating the auditory, motor, and reward systems. The demand for synchronised movement (Dance/Rhythm) facilitates the firing of Mirror Neurons and fortifies connections between the Motor Cortex and the Prefrontal Cortex, resulting in demonstrable improvements in inhibitory control and motor planning—a foundational requirement for functional autonomy.

- Embodied and Situated Cognition in Rehabilitation: The entire D.D.A.T.A. protocol is structurally founded on the premise of Embodied Cognition (Blake & Shiffrar, 2007). Learning is fundamentally achieved through the physical body's active interaction and manipulation within the immediate environment. Participants are not merely hearing music; they are actively manipulating adapted instruments (Malchiodi, 2012) and executing specific physical movements. This active, haptic learning effectively translates abstract cognitive goals into functional motor memory, offering a superior mechanism for the transferability of acquired skills (e.g., rhythmic precision translating directly into the ability to coordinate daily living tasks such as dressing or cooking). This principle is central to its utility as a powerful rehabilitative tool.

III. METHODOLOGY AND RESULTS

3.1 Participants and Design

A pilot, quasi-experimental design (Heineken & Sarris, 1986) was implemented. The convenience sample consisted of 27 adult participants (aged 18 to 45) diagnosed with Intellectual Disabilities (ID), all residing in Athens, Greece. The intervention spanned 12 weeks, with sessions conducted twice weekly (a total of 24 sessions). Participants were non-randomly assigned to an Experimental Group (n=14) receiving the D.D.A.T.A. intervention and a Control Group (n=13). This non-random allocation was necessitated by existing administrative and logistical constraints within the participating special education centres during the pilot phase, ensuring the practicality of the intensive intervention schedule. Preliminary baseline analyses meticulously confirmed the absence of any statistically significant pre-intervention differences between the two groups (Macri & Makris, 2014a; 2014b). Crucially, while the Experimental Group received the music- and movement-centric D.D.A.T.A. protocol, the Control Group only had exposure to the S.T.E.A.M. sensor hardware (i.e., the Pedal Switch) for rhythmic measurement purposes without receiving the structured therapeutic curriculum or the AI-driven adaptive feedback.

Table 1: Baseline Demographic and Clinical Characteristics of Experimental and Control Groups

Characteristic	Experimental Group (n=14)	Control Group (n=13)	Total (N=27)
Age ($\bar{x}$±SD)	28.3±4.5 years	29.1±5.1 years	28.7±4.8 years
Gender (Male/Female)	8/6	7/6	15/12
Level of ID (Mild/Moderate)	71.4%/28.6%	69.2%/30.8%	70.4%/29.6%

3.2 Measures and Adaptation for the Greek Context

The primary outcome measures were selected based on their established relevance to functional and behavioural rehabilitation outcomes:

A. Adaptive Behaviour (VABS Screener): Assessed using the Vineland Adaptive Behaviour Scales (VABS, 2nded.) (Sparrow et al., 2005; Icabone, 1999; Chen and al, 2008), which serves as a crucial, validated instrument for quantifying self-sufficiency and social skills—the ultimate, tangible goals of rehabilitation.

B. Motivation (MAS): Assessed using the Motivation Assessment Scale (MAS) (Durand & Crimmins, 1988), which is designed to functionally identify the underlying cause of maladaptive behaviours, with the therapeutic objective of replacing them with positive, motivated actions.

Adaptation and Administration: The instruments underwent translation into Greek and meticulous cultural adaptation. Following this process, a preliminary adaptation phase (pilot testing) was conducted to ensure linguistic clarity and cultural relevance before final administration. Given the inherent cognitive and communication limitations of the participants, both VABS and MAS were administered via structured interview with the primary caregivers and educators, strictly adhering to the scales' validated administration protocols (Gliner & Morgan, 2001) and ensuring the ecological validity of the data within the Greek research setting.

3.3 Description of the D.D.A.T.A. Intervention Protocol (Focus on Music-Motor Tasks)

The 12-week protocol was structured to systematically integrate music, motor skill development, and social practice:

Phase I: Rhythmic Decoding and Visual Coding (Weeks 1-4): Focused on establishing a reliable, direct link between auditory rhythm and the corresponding visual/motor response utilising the Pedal Switch and basic percussion. This phase prioritised the development of sustained attention and basic rhythmic accuracy (Macri & Makris, 2014c).

Phase II: Motor Skills Integration and Haptic Interaction (Weeks 5-8): Employed S.T.E.A.M. technology (capacitive sensors) to practice fine and gross motor skills through precisely controlled interaction with customised musical instruments. Tasks required graded force application and synchronised movement, serving as explicit, targeted rehabilitation exercises.

Phase III: Ensemble Performance and Socialisation (Weeks 9-12): Participants transitioned from individual skill practice to performing as a synchronised ensemble (following the "Ichochroma" model (Makris, 2015b; 2019)). This final phase maximised the transfer of acquired skills, reinforced social roles, and provided potent psychological reinforcement.

3.4 Quantitative Results

Table 2: Mean Scores ($\bar{x}$±SD) for Primary Outcome Measures (Adaptive Behaviour and Motivation) at Baseline and Post-Intervention

Measurement	Group	Baseline ($\bar{x}$±SD)	Post-Intervention ($\bar{x}$±SD)
VABS Screener (Total)	Experimental	38.9±4.2	46.1±4.7
	Control	39.5±4.5	40.8±4.3
Motivation (MAS) (Total)	Experimental	22.5±3.1	15.3±2.8
	Control	22.1±2.9	21.5±3.0

Table 3: Analytical Mean Scores ($\bar{x}$) for VABS Subscales at Baseline and Post-Intervention (Functional Gains)

VABS Subscale	Group	Baseline	Post-Intervention
Communication	Experimental	12.5	14.2
	Control	12.8	13.1
Daily Living Skills	Experimental	13.8	16.5
	Control	14.1	14.5
Socialization	Experimental	12.6	15.4
	Control	12.6	13.2

Table 4: Analytical Mean Scores ($\bar{x}$) for MAS Subscales at Baseline and Post-Intervention (Functional Motivation Shift)

MAS Subscale (Function)	Group	Baseline	Post-Intervention
Attention	Experimental	6.1	4.2
	Control	6.0	5.9
Escape/Avoidance	Experimental	5.8	4.9
	Control	5.7	5.5
Sensory	Experimental	5.5	3.5
	Control	5.4	5.3
Tangible	Experimental	5.1	2.7
	Control	5.0	4.8

Analysis of S.T.E.A.M. Sensor Data: The objective, sensor-based data unequivocally confirmed the efficacy of the music-motor protocol. The Experimental Group demonstrated a 78% reduction in rhythmic execution errors (from 11.5 to 2.5 errors per 100 trials) and an enhancement of Rhythmic Accuracy by 4.8 standardised units. These metrics provide the technological foundation and objective measurement of motor learning and synchronisation, which is the mechanism hypothesised to drive the functional gains observed in the VABS and MAS scores.

Table 5: S.T.E.A.M. Sensor Data: Objective Technical Gains in Rhythmic Performance (Experimental Group)

Measurement	Group	Baseline Mean	Post-Intervention Mean
Rhythmic Execution Errors (per 100 trials)	Experimental	11.5	2.5
Rhythmic Accuracy (Standardised Units)	Experimental	1.9	6.7

Statistical Analysis (Change Scores): Independent samples t-tests were conducted on the difference scores (Post-Intervention minus Baseline) between the two groups. The analysis revealed a highly statistically significant difference across both primary measures.

Table 6: Statistical Analysis of Change Scores (Δ): t-test and Effect Size (Cohen's d) Comparison Between Groups

Variable	Statistical (t)	df	p-value	Cohen's d
Change VABS (ΔVABS)	5.98	25	<.001	2.35
Change MAS (ΔMAS)	-7.02	25	<.001	2.74

The highly statistically significant p-values and the exceptionally large effect sizes (Cohen's d>2.3) furnish robust, compelling evidence that the D.D.A.T.A. intervention produced clinically important, non-trivial changes within the experimental group, particularly within the domains of Socialisation, Daily Living Skills, and Intrinsic Motivation.

3.5 Qualitative Findings and Clinical Observations (Rehabilitation Focus)

Detailed clinical observations meticulously corroborated the quantitative findings, specifically noting significant rehabilitative gains:

A. Improvements in Motor Coordination and Balance: Educators reported demonstrable improvements in fundamental Gross Motor Skills, including balance and temporal coordination. For instance, the improved ability to maintain the body's centre of gravity during musical movements and the refined accuracy of limb placement during rhythmic tasks directly translated to enhanced gait stability and a reduced risk of falls in daily life—events that are direct indicators of physical rehabilitation success.

B. Enhanced Sustained Attention and Task Initiation: Participants in the experimental group exhibited marked improvement in Sustained Attention, remaining focused on the musical task for significantly longer durations (evidenced by an 11-minute increase in active engagement time in pilot data). Moreover, the

music-based motivational structure substantially increased task initiation and compliance, both of which are crucial prerequisites for the successful implementation of any rehabilitation protocol.

IV. D.D.A.T.A. IN PRACTICE: S.T.E.A.M. AND TECHNOLOGICAL EVOLUTION

4.1 S.T.E.A.M. as the Enabling Technology: Precision in Rehabilitation

The incorporation of S.T.E.A.M. technology is not ancillary but foundational to achieving D.D.A.T.A.'s therapeutic precision (Makris, 2024):

A. The "Makris" Pedal Switch and Immediate Feedback: This initial technological tool established the mechanism of immediate, unambiguous Visual Signal feedback regarding the correctness of rhythmic input. By instantly confirming the motor action, the device optimises Motor Learning and minimises error rates, thereby accelerating the formation of correct motor habits—a core principle of effective rehabilitation.

B. Capacitive Sensors and Fine Motor Skills Quantification: The strategic use of Capacitive Sensors, Microcontrollers, and RGB Lamps effectively transforms basic objects into sophisticated diagnostic and therapeutic instruments. This technology permits the precise calibration and quantification of force application (Fine Motor Control) and rhythmic accuracy. These instruments facilitate exercises that specifically target the dexterity and strength required for rehabilitation, elevating the intervention beyond subjective observation into a quantified biomechanical practice. The objective, quantifiable sensor data (Table 5) directly demonstrates the technology's critical role in driving functional improvement.

4.2 The Implementation and Impact of Artificial Intelligence (AI) in Personalised Rehabilitation

The development and pilot application of an autonomous AI system represent the next critical phase for D.D.A.T.A., aiming for fully automated, individualised therapy and future scalability:

A. AI for Automated Curriculum Personalisation (The Adaptive Music Score): The envisioned AI system will function as a highly sophisticated clinical tool. It will continuously analyse the input data streamed from the sensors (rhythmic error rate, applied force, latency) and instantaneously adjust the musical composition and the corresponding visual cues in real-time. If a participant struggles, the AI autonomously simplifies the tempo or the harmonic structure; if mastery is achieved, it incrementally increases the complexity. This creates a perpetually individualised Adaptive Music Score, representing the gold standard of personalised neuro-rehabilitation by ensuring the participant is always learning at their optimal, adaptive threshold.

B. The Role of Advanced Sensors (IMUs, Computer Vision) in Objective Measurement of Gait and Posture: The future vision entails the comprehensive deployment of advanced sensors. Inertial Measurement Units (IMUs) can be strategically positioned to yield objective kinematic data concerning joint angles, gait patterns, and overall postural stability during musical movement. Similarly, Computer Vision is utilised to track and quantify subtle facial expressions and body language, enabling the system to monitor emotional state and engagement. This technological triangulation allows for the replacement of subjective clinical assessment with continuous, quantified data streams, furnishing an unprecedented level of precision in measuring rehabilitative progress.

V. DISCUSSION: ESTABLISHING A FUNCTIONAL RESEARCH FRAMEWORK

5.1 Critical Evaluation of Functional and Rehabilitative Gains

The observed effect sizes ($d>2.3$) across Adaptive Behaviour and Motivation are not merely statistically significant; they robustly signify a transformative functional shift in the lives of the adult participants. The substantial gain in VABS scores, juxtaposed against the minimal change observed in the control group ($\Delta\bar{x}=+7.2$ vs. $\Delta\bar{x}=+1.3$), critically suggests that the non-specific, passive exposure of the control condition is insufficient to induce functional change in this population. The D.D.A.T.A. model, through its structured, technology-mediated artistic demands, appears to possess a specific, potent therapeutic mechanism capable of accelerating adaptive skill

acquisition. The efficacy of artistic engagement in treating neurological conditions has been widely validated, emphasising that music, rhythm, and movement actively engage the brain's motor and reward systems, generating robust pathways for learning and neurological repair (Koelsch, 2010). The sustained improvement in Motivation (MAS) confirms that the musical context itself successfully overcomes the common barrier of poor task compliance frequently encountered in traditional rehabilitation settings. Furthermore, the author's continued active involvement in clinical practice and the method's ongoing evolution are directly motivated by the sustained, observable functional improvements and increased motivation consistently seen in participants—a powerful, real-world justification for its necessary evolution into a technologically autonomous therapeutic system..

5.2 The Necessity of Technological Autonomy and Standardisation

The strategic move toward a sensor- and future AI-driven model is driven by both clinical efficacy and ethical necessity. The technological autonomy afforded by the D.D.A.T.A. system is absolutely essential for its future standardisation across varied clinical and educational settings. Furthermore, this system directly addresses a critical methodological challenge in special education and rehabilitation: the problem of inter-rater variability and potential subjective assessment bias (Vera, 2022). By relying on sensors for objective kinematic and temporal measurement, the D.D.A.T.A. system ensures transparency, accountability, and reliability in evaluation, replacing reliance on highly subjective, human-dependent psychometric tests with continuous, quantified progress metrics.

5.3 International Recognition and Validity

The D.D.A.T.A. methodology has already garnered significant international recognition, thereby validating its core scientific and clinical relevance:

A. International Systematic Review (2024): It was included as the sole relevant reference for Greece in the International Systematic Review (2014–2023) published by the International Journal of Learning, Teaching and Educational Research (Fajrie and al, 2024).

B. Cross-Border Adoption: The practical utility of the methodology was formally confirmed by the official certification and adoption of D.D.A.T.A. protocols by educators at the Alytus Music School in Lithuania under the Erasmus+ program, proving its cultural transferability and clinical applicability outside the Greek context.

5.4 Therapeutic Autonomy and Future Institutionalisation

The definitive success and international recognition of D.D.A.T.A. necessitate its crucial transition from an applied clinical model to a core, stable, University-based research program. The complexity and pioneering nature of D.D.A.T.A., which fuses Pedagogy, Neurosciences, Applied Behaviour Analysis (ABA), and advanced Engineering/Artificial Intelligence, mandate its formal integration within a dedicated University Research Institute or Centre. Such institutionalisation is indispensable for:

A. Scientific Continuity and Scalability: Ensuring the long-term, systematic evolution of the methodology and securing the specialised infrastructure required for complex technological integration (e.g., full-scale AI validation).

B. Funding Stability: Gaining access to competitive national and international research grants (e.g., Horizon Europe) is essential for long-term data standardisation and the comprehensive technological development of the system.

C. Interdisciplinary Collaboration: Guaranteeing continuous access to dedicated academic expertise in its core disciplines. This stable academic platform is the critical prerequisite for achieving true functional inclusion and significantly enhancing the long-term quality of life for individuals with Intellectual Disabilities, by enabling the transition from a pilot model to a standardised, evidence-based therapeutic framework.

VI. CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH

6.1 Conclusions

The Differentiated Didactic Approach to the Arts (D.D.A.T.A.) provides strong preliminary evidence for its efficacy as a promising pilot

therapeutic model for adults with Intellectual Disabilities. The study's findings are compelling, supporting all stated hypotheses by demonstrating highly significant gains in Adaptive Behaviour and Motivation—results that suggest the potential for increased functional independence. The methodology's success stems from its unique fusion of structured artistic engagement, sound neuroscientific principles, and adaptive technology, indicating its potential as a robust neuro-rehabilitative tool that appears substantially more effective than the passive control condition. The exceptional size of the observed effects (d>2.3) strongly supports the potential clinical relevance of the D.D.A.T.A. model and serves as a robust preliminary data foundation for subsequent large-scale studies.

6.2 Limitations of the Current Study

Despite the strength of the reported results, the study contains inherent limitations. First, the sample size (N=27) for the quantitative analysis remains relatively small, suggesting prudence in generalising the findings, notwithstanding the extensive cumulative experience with N=512. Second, the pilot quasi-experimental design relies on non-random assignment, which inherently introduces the possibility of selection bias, although baseline equivalence was confirmed. These limitations underscore the immediate priority for a large-scale Randomised Controlled Trial (RCT). Finally, the AI and advanced sensor applications are currently operating at the pilot and developmental stage; comprehensive, full-scale validation trials are required to integrate these technologies into the core therapeutic protocol.

6.3 Future Directions (Neuro-imaging and Technology)

Future research must concentrate on achieving full scientific validation through:

A. Longitudinal Studies: To critically assess the long-term maintenance and transferability of the functional gains in real-world settings (e.g., employment, independent living).

B. Neuro-Imaging Validation: The ultimate scientific validation of the D.D.A.T.A. method lies in demonstrating its hypothesised effect on the brain. Future studies must strategically employ neuroimaging technologies (e.g., EEG or fMRI) to objectively quantify the music-induced cortical reorganisation and neuroplastic changes observed during the intervention.

C. Randomised Controlled Trials (RCTs): A large-scale, multisite RCT is required to definitively eliminate selection bias and confirm the exceptionally large effect sizes observed in this foundational pilot study, thereby establishing D.D.A.T.A. as a globally recognised, evidence-based therapeutic standard.

VII. DECLARATIONS

7.1 Ethical Statement

The study was conducted in strict accordance with the ethical guidelines of the Declaration of Helsinki. The voluntary attendance and participation of all individuals were secured, and formal informed consent was obtained from their legal guardians/proxies prior to their inclusion in the study, reflecting the participants' capacity. The protocol was reviewed and deemed ethically acceptable by the appropriate institutional and administrative authorities at the time of commencement, ensuring complete confidentiality and anonymity throughout the research process.

7.2 Conflict of Interest

The author is the creator of the Differentiated Didactic Approach to the Arts (D.D.A.T.A.) methodology. This interest is declared transparently. The research was conducted strictly for academic purposes, and its design, execution, and reporting were performed without bias. The commercial exploitation of the patented methodology is subject to strict academic review and the judgment of the author and founder of the method.

7.3 Funding (Χρηματοδότηση)

This research received no external funding, governmental support, or institutional resources from the author's affiliations. The study was conducted utilising the personal resources and commitment of the author. This self-funded approach, while underscoring the author's deep personal belief in the methodology's real-world impact, simultaneously highlights a critical bottleneck for future scalability and global validation. The subsequent large-scale research phases—including the mandatory large-scale,

multisite Randomised Controlled Trial (RCT), the comprehensive technological scaling and validation of the autonomous AI system, and the essential neuro-imaging studies (EEG/fMRI) required to scientifically validate the hypothesised cortical reorganisation mechanism—demand resources far exceeding those available privately. Given the exceptionally large and clinically significant effect sizes (d>2.3) and the robust objective gains demonstrated by the S.T.E.A.M. sensor technology, the D.D.A.T.A. methodology has demonstrated the high potential return on investment. Therefore, we call upon national and international competitive research bodies (e.g., Horizon Europe, NIH, or specialised foundations) to recognise this validated, high-impact pilot data as the definitive justification for securing the immediate, stable academic and financial framework necessary to achieve evidence-based therapeutic standardisation and global implementation.

7.4 Data Availability Statement (Δήλωση Διαθεσιμότητας Δεδομένων)

The quantitative and qualitative data supporting the findings of this study cannot be deposited in a public repository due to the requirement to protect the anonymity and confidentiality of the vulnerable participant population (adults with Intellectual Disabilities) and their primary caregivers, in accordance with the ethical approval received. Requests for access to non-identifying, aggregated statistical data may be considered by the corresponding author upon reasonable request and subject to adherence to confidentiality protocols

7.5 Author Contributions

I. M. is the sole author of this manuscript. I. M. was fully responsible for the conceptualisation of the D.D.A.T.A. methodology, the design of the quasi-experimental study, data collection, formal analysis, writing—original draft preparation, and writing—review and editing.

7.6 Statement on Generative AI Use

Generative Artificial Intelligence (AI) tools were utilised exclusively for linguistic refinement and translation purposes during the manuscript preparation (specifically, from Greek to English). The application of AI was strictly confined to enhancing the clarity, flow, and grammatical accuracy of the final text. Crucially, the use of these tools did not involve the generation or alteration of the scientific content, research methodology, data analysis, or the derived conclusions. The sole author remains entirely responsible for the scientific integrity and intellectual content of this research.

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OPEN ACCESS

Mexico's Oil Industry 2019-2025: National Sovereignty and Energy Self-sufficiency Without Development?

Roberto Gutierrez-Rodriguez[δ]

ABSTRACT

This paper aims to put into perspective the insufficiency of the rescue strategy for Mexico's oil industry during the 2019-2025 period, which covers the administration of Andrés Manuel López Obrador (AMLO) and impacts the first months of the subsequent administration. The paper's hypothesis is that the energy policy actions applied to the oil industry responded to a confused understanding of national sovereignty and energy self-sufficiency in an environment where it is difficult to determine whether there was even a legitimate concern about the country's future development and the role that oil could play in it, given the importance it had in the industrialization process (import substitution industrialization and manufacturing exports-led growth). To clarify this, the text evaluates, through the method of comparative statistical analysis, the degree of compliance of the seven main hydrocarbon-related tasks self-imposed by the AMLO administration. Based on official figures, it shows that, as of April 2025, none of the tasks had been completed, except for that referred to the reversion of the energy reform and those determined by inertial factors or financial and human resources to which the government had broad access. In this environment, after a six-and-a-half-year wait and a great deal of committed resources, the situation of the oil industry, far from improving, worsened.

Journal: Boston Research Journal of Social Sciences & Humanities
Keywords: Oil industry, energy reform, national sovereignty, energy self-sufficiency, planning, development.
Accepted: 27 October 2025
Published: 15 November 2025
ISSN: Online ISSN: 2834-4863 | Print ISSN: 2834-4855
Language: English
Research ID: 35f9e999-b6c8-4f71-a075-df3b67dc52bf
Type: Peer-Reviewed Research Article (Open Access)

The authors declare that no competing interests exist. The authors contributed equally to this work.

Read Online: https://rebrand.ly/hbts0y2

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I. INTRODUCTION

Between late July and early August 2025, Mexicans were informed by the Ministry of Finance and Public Credit (SHCP) of the execution of an offering of pre-capitalized notes (P-Caps) guaranteed by the federal government. This to ensure that Petróleos Mexicanos (PEMEX), the oil company recently reabsorbed by the State (previously classified as a State Productive Enterprise – EPE), would have sufficient liquidity to meet part of its financial obligations for that year. This resulted in the issuance of US$12 billion in bonds at an annual yield of 5.5%, half of what PEMEX would have paid, which five years earlier had lost its investment-grade status from two of the three major credit rating agencies. They would be used to acquire principal, bond, and interest-bearing securities from the United States Treasury to optimize the maturity profile of PEMEX's debt and reduce its liabilities and financial costs. Upon maturity, on August 17, 2030, these securities must be covered by the company; otherwise, they will become public debt.

This negotiation was a reminder of PEMEX's precarious financial situation, with its external debt profile showing maturities of over US$21 billion throughout 2025 and a higher amount in 2026, in addition to its debt to suppliers, which amounted to more than US$20 billion in July 2025. These suppliers increasingly exerted pressure on the State, even ceasing exploration, production, and maintenance work in support of the state-owned oil company. This partly could explain the reduction in hydrocarbon production during the second half of 2024 and the first half of 2025.

How the state-owned oil company could have ended up in such a dire situation is something we all wonder, since the AMLO administration's proposal was exactly the opposite: transition from the 2013-2014 energy reform to the 2019-2025 counter-reform; Substantial increase in hydrocarbon exploration and production; Self-sufficiency in refined products and fertilizers; Taking into account citizens' opinions, including fracking, contracts, and daylight saving time; Prioritizing refined product production over crude oil exports; Constant fuel prices and combating fuel theft; and Financial rehabilitation of PEMEX. The hypothesis is that the strategy failed and that more than just fidelity to the principles of national sovereignty and energy self-sufficiency is required; that is, the oil industry must be redirected to increase hydrocarbon exploration and production, as well as the utilization rate of installed refinery capacity, in addition to increasing the company's productivity and competitiveness, either through the measures proposed by AMLO or those that are required.

The analysis is carried out as follows: The first section presents a summary of the reorientation of development policy since AMLO's administration, taking into account the range of economic policy elements implemented during his administration. Section 2 observes the process of transition from the 2013-2014 energy reform to the 2019-2025 counter-reform. Section 3 analyzes each one of the seven tasks of AMLO's hydrocarbon policy. Section 4 presents the results and discussion. Finally, the conclusions are presented.

II. THE REORIENTATION OF DEVELOPMENT POLICY IN 2019

The political group that assumed power in Mexico in December 2018, led by a charismatic man with a humanist bent, AMLO, founder and leader of the recently formed National Regeneration Movement (MORENA), championed political, economic, and social proposals that proved highly convincing to voters. Among them was a sentiment that appealed to nationalism and contrasted with the highly market-oriented liberal policies under which the country had been administered since December 1982. Its implementation would be carried out through a series of reforms and counter-reforms imposed thanks to MORENA's supremacy in both chambers of Congress. In the political sphere, public administration would be reorganized, and the judiciary, public security, electoral processes, and forms of popular representation would be reformed. In the economic sphere, various areas would be reconsidered, focusing efforts on energy, telecommunications, regional development, competition, and foreign relations. In the social sphere, new reforms would be implemented in the areas of wages, attention to poverty and marginalized groups, labor-management relations, working conditions, the pension system, education, and public health.

Over the 35 years between 1983 and 2018, Mexico underwent a path of profound transformations that sought to lay the foundations to provide the economy with the elements that

would allow it to resume the high growth rates experienced during the so-called Mexican Miracle (Hansen, 1974). The possibility of achieving this was stimulated by the development experience of Southeast Asian countries since the 1960s (Stiglitz, 1996; Yosuf and Stiglitz, 2001). Unfortunately, the model suffered from a structural flaw that no one inside or outside the country could overlook: the neglect of traditionally disadvantaged social groups. That is to say, even in an environment of high economic growth, and assuming that this would stabilize poverty levels, the market would still be unable to halt the rise of inequality. This dichotomy has been addressed by various scholars in economic and social development based on cross-section analysis, among others, and was corroborated in far-reaching research studies such as that of Piketty (2013).

The approach of the government inaugurated by AMLO was appropriate in terms of correcting the distortions generated by his predecessors, whom he described as technocrats and neoliberals. He addressed this through an unprecedented push for minimum wages, a regional reorientation of development toward the southeast and center regions of the country, and a readjustment of poverty alleviation programs. In this area, coverage increased for unemployed youth, students, the elderly, rural residents, coastal residents, single mothers, and people with disabilities. These social programs were implemented by displacing the targeted poverty alleviation system that had been in place since 1992 (the Solidarity and successor programs), based on a methodology primarily designed by an international organization, the World Bank (Gutierrez-Rodriguez, 2025).

The package's coverage was so widespread that in the medium term, it sought to protect 30 million of the country's 38.5 million families by granting each of them at least one social program. However, it was clear that the amount in pesos would not guarantee the eradication of poverty, either individually or as a family. On the contrary, it would undermine average labor productivity (OECD, 2025a), and stipends would be prioritized over options for further education and an increase in the labor market participation rate, one of the lowest internationally (OECD, 2025b). Similarly, as multiple observers warned, there would not be sufficient public resources —particularly from a solid tax base— to finance such expenditures without neglecting areas such as health, education, science and technology.

To achieve the aforementioned change of course, the Executive had to face the dilemma posed 45 years earlier by Hansen (1974) of addressing social commitments stemming from the Revolution that were growing rapidly due to demographic growth, or financing public policies to boost economic development. Given MORENA's founding ideology, which was more economically oriented toward the short term than the long term, the party leadership opted for the former, for which it had the unconditional support of Congress. This led the Executive Branch from the outset to neglect not only the completion of ongoing public works and the maintenance of infrastructure but also the construction of new infrastructure.

III. FROM THE 2013-2014 ENERGY REFORM TO THE 2019-2025 COUNTER-REFORM

Regarding hydrocarbons, the government that assumed power at the federal level in December 2018 (and repeated as a political group, led by MORENA, in October 2024) outlined seven major tasks in various forums, statements, and interviews, before and after taking office, and not only in official energy planning documents. The first task was strategic and medium-term, consisting of restoring the vertical integration of the then-EPE, PEMEX, so that it could regain the status it had held prior to the 2013-2014 energy reform, based on considerations of national sovereignty and energy self-sufficiency. This was complemented by the idea of avoiding redundancy of functions between PEMEX and its subsidiaries, which, following the 2013-2014 energy reform, were also defined as EPE, with their own legal personality and assets, although subject to the management, direction, and coordination of the PEMEX corporation.

The second task, within the framework of six defined for the short and medium term (2019-2024), was to accelerate hydrocarbon exploration and exploitation work in order to increase crude oil production from 1.73 Million Barrels Daily (MBD) and natural gas production from 4,881 Billion Cubic Feet of gas Daily (BCFGD), recorded in December 2018 (PEMEX, 2025), to 2.9 MBD and 5,500 BCFGD, respectively, no later than 2024. The production of more hydrocarbons would be carried out facing unprecedented restrictions imposed by the federal government itself, starting with the fact that exploration work would be limited

from that moment on to land and shallow waters. This did not imply ignoring the current exploration and exploitation contracts won by private enterprise, which would be respected as long as they complied with the legal framework.

Third, the goal of achieving self-sufficiency in refined products was proposed, given that fuel imports accounted for nearly 80% of total demand in 2018. Rhetorically, this would be achieved by modernizing the six PEMEX-owned refineries in the country, which would also entail equipping the Salina Cruz and Tula refineries with coking plants to produce more gasoline and diesel and less fuel-oil. A new refinery would also be built in Dos Bocas, Tabasco, officially named Olmeca, as large as the last one built in the country in 1979 (Salina Cruz, Oaxaca) and the one owned by PEMEX in Deer Park, Texas, both with a processing capacity of 340,000 barrels per day (BPD). Likewise, self-sufficiency in fertilizers would be achieved by putting into operation various ammonia plants that had been idle for about 20 years in Cosoleacaque, Allende, and Poza Rica, Veracruz, as well as in Lázaro Cárdenas, Michoacán.

Fourth, community rights would be respected above the objectives of exploration, exploitation, and transformation of energy resources; time zone management would be reviewed; the use of hydraulic fracturing (fracking) techniques would be eliminated; and the bidding process for hydrocarbon exploration and production areas would not be resumed until a careful review of the contracts awarded during the previous three and a half years, including the possibility of penalizing any noncompliance. Additionally, the participation of private companies in electricity generation would be limited to 46%.

Fifth, domestic production of refined products would be given priority over crude oil exports, with exports falling to zero before the end of the 2019-2024 six-year term, coinciding with the full operation of the Dos Bocas refinery, and the modernization of the other six refineries. As previously stated, Tula and Salina Cruz would be equipped with coking plants.

Sixth, fuel prices, particularly gasoline and diesel, would be kept constant in real terms, and pipeline smuggling, known as huachicol, would be aggressively combated, as it was pointed out as the most serious problem of losing resources, with no enough mention of corruption.

IV. DEGREE OF GOALS ACHIEVEMENT

4.1 Legal reversal of the 2013-2014 energy reform

The strategic objective of reversing the energy reform involved returning PEMEX and the Federal Electricity Commission (CFE) to their status as vertically integrated public companies with a high degree of monopoly; that is, they would regain the almost absolute responsibility they had held for managing the oil and electricity industries. This was carried out through a process that began in December 2018 when AMLO took office and was consolidated in March 2025, five months after the inauguration of President Sheinbaum's administration (2024-2030). The exercise consisted of a series of legal and administrative actions that required the support of Congress and were made possible thanks to the absolute majorities that both governments enjoyed in both the Chamber of Deputies and the Senate, based on the votes obtained in the general elections by their political party, MORENA, and its allies, the Labor Party (PT), the now-defunct Social Movement Party (PES), and the Green Ecologist Party of Mexico (PVEM). Particularly significant was the effort to return constitutional articles 25, 27, and 28 to their near-original state between October 31 and December 20, 2024. Additionally, two autonomous bodies, the Energy Regulatory Commission (CRE) and the National Hydrocarbons Commission (CNH), were dissolved. Their regulatory functions were absorbed by the Ministry of Energy (SENER), which subsequently transferred them to a newly created body under its supervision, the National Energy Commission (CNE). This effectively ended a state regulatory model that had been in place for almost 35 years.

The secondary legislation derived from the previous constitutional changes was implemented through a decree published in the Official Gazette of the Federation on March 18, 2025, issuing eight laws: the Law of the State-Owned Enterprise, Federal Electricity Commission; the Law of the State-Owned Enterprise, Petróleos Mexicanos; the Electricity Sector Law (LESE); the Hydrocarbons Sector Law (LESH); the Energy Planning and Transition Law; the Biofuels Law; the Geothermal Energy Law; and the Law of the National Energy Commission. Additionally, various provisions contained in the Law of the Mexican Petroleum Fund for Stabilization and Development and in the Organic Law of the Federal Public Administration were amended.

The practical results of the aforementioned adjustments, and even a series of actions prior to them, could be predicted in December 2018, with the suspension of the bidding process for onshore and offshore hydrocarbon blocks, leaving the institutional distribution of probable (P2) and possible (P3) hydrocarbon reserves as they were until then: 83% under PEMEX's control and the remainder controlled by many private, national, and foreign companies. Although it was stated that the process would resume once the contracts were reviewed, this did not happen. On the contrary, faced with legal uncertainty, as well as the lack of success of some exploratory exercises, several private companies that had won exploration and production contracts, either alone or in consortiums, chose to forgo them. By 2023, 38 blocks tendered to private companies, equivalent to one-third of the total (111 at the time), had been fully or partially returned to SENER. As a result, PEMEX's share of P2 and P3 reserves increased to 85%, and its total crude oil and condensate production rose from 90% at the end of 2021 to 95% in 2024 (Gutiérrez-Rodríguez, 2022; PEMEX, 2025). This means that, at least in hydrocarbon production, when we talk about PEMEX, we are talking about practically an entire industry.

One case that was on the verge of becoming a repossession and even an international conflict was the Zama mega-field, discovered in July 2017 in shallow waters of the Gulf of Mexico, at a depth of approximately 500 meters, by the winning consortium of Block 7 in bidding round 1.1, led by the US company Talos Energy. Initial calculations established that it would enter operation in 2025, reaching a maximum production of 180 thousand barrels per day (TBD) of high-quality light crude and 2,388 MCFGD, with a start-up expenditure of just over US$9 billion: US$4,541 million earmarked for investment and US$4,544 million for operating gas. Given that the megafield borders an allocation made by SENER to PEMEX, the EPE entered into a dispute with Talos over its control from the beginning of AMLO's administration. In July 2021, SENER awarded PEMEX the operation of the project, prompting Talos to express its intention to ask the US-Mexico-Canada Agreement (USMCA) to arbitrate the case, although it later withdrew. In March 2022, the unification of the megafield was completed, and Talos retained a 17.35% stake. Once this was negotiated, and with PEMEX as the operating company, both presented the Zama development plan to the CNH in March 2023, which was approved the following June and constitutes PEMEX's main project, along with the Trion field, located in deep waters of the northern portion of the Gulf of Mexico (2,500 meters), with Woodside Energy then as the operator, with a 49.6% stake, while PEMEX Exploration and Production (PEP) owns the remaining 50.4%. This is changing as in August 2025 PEMEX in alliance with Grupo Carso decided to take over the project and become the operators, facing possible litigation.

A similar action was taken in the wholesale electricity market (MEM). On one hand, in 2019, the bidding process in such a market was postponed. On the other hand, the incorporation of wind and solar photovoltaic energy from generating companies that had won bids and even from those units that, not dedicated to generation but to other activities, had surpluses (self-supply companies) was limited, arguing that they destabilized the system. As a corollary, the Electricity Industry Law was amended to limit the overall participation of private companies in generation to a maximum of 46%, leaving the remaining 54% to CFE. Within this framework, the Spanish company Iberdrola announced, in the second half of July 2025, that for reasons related to Mexico's legal and fiscal stability, it would sell its 15 renewable energy plants, valued at $4.7 billion, and would leave Mexico after 16 years of presence. This came after, just in 2023, it had consolidated the sale of 55% of its assets to the Mexico Infrastructure Partner (MIP) fund, with participation from the Mexican government, for US$6 billion, selling 13 combined-cycle power plants with a capacity of 8,534 megawatts. These plants were taken over by the National Infrastructure Fund (FONDIN) as the majority shareholder and vehicle to refinance the transaction, which government circles described as "a new nationalization of the electricity market", since with it, the CFE consolidated its majority control over it. However, in the end, the transfer was made to the Cox Group, also from Spain.

In March 2025, two steps were taken simultaneously to eliminate redundancies. Firstly, four out of the seven PEMEX subsidiaries were consolidated: PEMEX Drilling and Services (PPS), PEMEX Cogeneration and Services (PCS), PEMEX Fertilizers (PF), and PEMEX Ethylene (PE). Secondly, three EPE were transformed into Subsidiary Productive Enterprises (EPS): PEP, PEMEX Industrial Transformation (TRI), and PEMEX Logistics (LOG). The main difference between EPE and EPS is that

the latter are subsidiaries created in accordance with the laws applicable to each of the jurisdictions in which they were incorporated. Additionally, the dissolution of CFE's 10 subsidiary companies was decided: CFE Transmission, CFE Distribution, CFE Basic Supply, and CFE Generation I, II, III, IV, V, and VI, as well as CFE Telecommunications and Internet for All, which would be replaced by administrative units. Consequently, the generation, transmission, distribution, electricity supply, and marketing activities in the wholesale electricity market were transferred to CFE's Corporate Operations Directorate, while telecommunications and internet activities were transferred to the Corporate Commercial Business Directorate. The National Energy Control Center (CENACE) remains a decentralized body, independent of CFE.

4.2 Substantial increase in hydrocarbon exploration and production

In implementing the second task to accelerate hydrocarbon exploration and exploitation to boost daily crude oil and gas production, the results were contrary to projections. Proven reserves and hydrocarbon production decreased instead of increasing, and exploration activity also declined. Proven reserves decreased from 13 to 8.4 billion barrels of oil equivalent (BBOE) between 2015 and 2024 (CNH, 2025); oil production decreased 38% and gas 27.3% (PEMEX, 2025). Although some gas wells were discovered, oil remained the primary focus. By 2024, the reserves/production ratio stood at just 8.7 years. To achieve growth, new reserves need to be discovered at a faster rate than extraction, posing a challenge despite the declining domestic demand for refined products and controlled exports, as discussed later.

Another notable fact about reserves in 2024 was their relative concentration in the southeastern region, both offshore (55% of the total) and onshore (16.4). The rest was: Veracruz, 10.9%; Deep Gulf of Mexico, 5.8%; Land Tampico-Misantla, 0.7%, and the rest of the territory, 11.2% (CNH, 2025). This, on the one hand, reflects the limited progress made in exploring and developing new wells and fields, particularly on land. On the other hand, the government's self-imposed straitjacket, which resulted in very little progress in deepwater exploration in the Gulf of Mexico, with reserves reaching just 5.8% of the total, and in fields susceptible to fracking (north-northeast of the country).

Furthermore, the number of wells drilled and completed by PEMEX declined systematically starting in 2015. Between that year (610 wells) and 2024 (276), the reduction was 46%; between 2018 (328 wells) and 2024, it was 16%; and if the figures observed between January and April 2025 (44) are annualized (132), the drop compared to 2024 would be 33% (CNH, 2025 and SENER, 2025). In fact, the first strategy outlined by the administration that assumed control of PEMEX at the end of 2024 was to recover the remaining hydrocarbons in existing wells using both secondary and tertiary (improved) techniques, as well as drilling to greater depths. This evidently has several problems: it guarantees short extraction horizons, since it increases the well recovery rate by an average of 15%, but it also increases production costs by up to 30% and has harmful effects on the environment due to the components that must be injected into the well, specifically carbon dioxide (CO_2), the greenhouse gas with the greatest presence in Mexico's environment.

As a result, crude oil production experienced a sharp decline between December 2015 and April 2025, dropping from 2,275,000 BPD in the first period to 1,359,518 BPD in the second (a cumulative reduction of 40%). The decline was offset by the entry into operation of two wells producing condensates or natural gas liquids: Quesqui, located in Tabasco, and Ixachi, located in Veracruz, whose production was added to crude oil production under the direction of PEMEX. Consequently, liquid hydrocarbon production decreased from the figure indicated in December 2015, when both concepts were not consolidated, to 1,627,346 barrels per day in April 2025, implying a cumulative reduction of 28.5% (PEMEX, 2025).

Bear in mind that gas condensate fields have the following characteristics: the hydrocarbon mixture is composed of more than 60% methane gas, as in dry and wet gas fields, while the amount of heavy hydrocarbons is considerably higher. Condensates are byproducts of hydrocarbon drilling that can be found in liquid or gaseous form, depending on the pressure and temperature at the time of release. Although they are used as raw materials for the manufacture of fuels, i.e. they are primarily gasoline known as natural gasoline, they are essential in the manufacture of certain plastics and effective in stabilizing heavier crude oil, giving it desirable properties before it is sent to refineries. Condensates must be stabilized before use or

transportation. This is not only due to their explosive nature but also because they contain impurities such as CO_2 and hydrogen sulfide (H_2S), which can corrode the interior of pipelines, pipes, and tanks.

4.3 Self-sufficiency in refined products and fertilizers

Along with the decline in crude oil production, fewer and fewer petroleum products were processed, despite the original idea being to prioritize the industrialization of the raw material rather than seeking to place it on the international market (exporting orange juice, not whole oranges, as it used to be said). On one hand, oil production decreased from 2.275 TBD in December 2015 to 1.729 TBD in December 2018, and further to 1.627 TBD in April 2025. On the other hand, refined oil production decreased from 1.267 TBD to 740.6 TBD, and then to 331.9 TBD over the same period. Thus, refined oil production relative to crude oil production, which includes condensates in the previous figures, particularly from March 2020 (1.5% of total liquid hydrocarbons production) to April 2025 (16%), fell from 55.7% in December 2015 to 42.8% in the same month in 2018, and to only 20.4% in April 2025 (PEMEX, 2025).

Self-sufficiency in gasoline and diesel remained elusive, although the international energy transition process began to take effect and Mexico benefited from it, thanks to the penetration of more efficient vehicles into the domestic market. First, the vehicle fleet included more compact vehicles; then, hybrids were added, and more slowly, electric vehicles. Thus, while PEMEX's domestic sales of gasoline and diesel decreased from 1.2 MBD in December 2015 to 1.04 MBD in the same month of 2018 and to 1.0 MBD in April 2025, its gasoline and diesel imports fell from 572.4 TBD in the first month to 360.7 TBD in the last, after having reached record levels in December 2018 (833.6 TBD). With this, PEMEX's dependence on imported gasoline and diesel fell from 47.2% in December 2015 to 35.9% in April 2025, after having reached a peak of 79.8% in December 2018 (PEMEX, 2025). As will be seen later, imports by private parties, which depend on a permit granted by SENER (Procedure SENER-09-002 Permit for the import of petroleum products), as well as fiscal huachicol (practically smuggling), distort the figures.

Unfortunately, Mexico's heavy crude oil production (Maya, 22 degree-API) is so high in relation to total production (50.5%), and five of the six original refineries are so poorly adapted that the increasing gasoline production leads to the generation of what has become an undesirable byproduct due to its high pollution levels: fuel oil, with a high sulfur content. Although gasoline production did indeed increase in April 2025 (344.3 TBD) compared to December 2018 (207.1 TBD), thanks to the Dos Bocas refinery entering into operation at 35% of its installed capacity, fuel oil production also increased (even without Dos Bocas, in December 2015 gasoline production amounted to 381.4 TBD) (PEMEX, 2025). Meanwhile, the ratio of this byproduct to gasoline remained at the level it had in 2015 (62%), when fuel oil could still be exported, and the remainder could be used both as fuel for ships on the high seas and as a raw material for the generation of electricity in many thermoelectric plants, without having to face today's ecological restrictions, by virtue of international agreements.

Looking more closely at this point, national production of refined products (gasoline, diesel, liquefied gas, kerosene, and fuel oil) decreased from 1,123,703 BD in December 2015 to 929,522 BD in April 2025, despite the addition of 84,080 BD from the Dos Bocas refinery. Although final figures for this refinery are being withheld, it would ultimately cost the treasury US$21 billion. The largest share of processing in April 2025 corresponded to Tula, with 22.4% of national production, followed by Salina Cruz, with 20.3%, and Cadereyta, with 14.8%. If Salamanca (14.3%) and Ciudad Madero (11.4%) are added to these three, the cumulative share reaches 83.2%. The remaining two are Dos Bocas (9.1%) and Minatitlán (7.7%), as shown in Table 1

Table 1. Crude and liquids per refinery processing Thousand barrels per day

Refinery	Dec. 2015	Particip (5)	Dec. 2018	Particip (%)	Apr-25	Particip (%)	Quality of oils used relation in 2025*
Cadereyta	187,244	16.7	113,105	22.1	137,725	14.8	Heavy and light equal proportion
Cd. Madero	118,674	10.6	-	0	106,251	11.4	Heavy
Minatitlán	139,672	12.4	-	0	72,063	7.7	Heavy
Salamanca	151,164	13.4	74,674	14.6	133,148	14.3	Light+superlight/heavy= 4 to 1
Salina Cruz	260,792	23.2	150,540	29.5	188,412	20.3	Light/heavy= 2.5 a 1
Tula	266,158	23.7	172,285	33.8	207,843	22.4	Light+superlight/heavy= 4 a 1
Dos Bocas	-	0	-	0	84,080	9.1	Heavy
TOTAL	1,123,703	100	510,604	100	929,522	100	

*Maya (heavy, 22 degree-API); Zapoteco (light, 29.0-29.5 degree-API); Istmo (light, 32 degree-API); Olmeca (superlight, 39 degree-API).

Source: PEMEX (2025)

To comply with environmental regulations, the crude oil mix that each refinery can handle varies greatly. On the one hand, thanks to its on-site coking plant, Dos Bocas processes almost entirely heavy crude. Something similar happens, albeit for different reasons, with the refineries in Ciudad Madero and Minatitlán, although their share of production is very low. This is also the case with the Cadereyta refinery, which faces regional disputes over the greenhouse gases it generates. Due in part to this situation and in part to their high production costs, the first two stopped producing for many months and even years during 2014-2016. The case of Cadereyta is very pressing from a social perspective, due to its proximity to the municipality of Monterrey and its metropolitan area. The ratio of light crude to superlight crude to heavy crude processed by Salamanca and Tula is 4 to 1. Finally, Salina Cruz has a ratio of 2.5 to 1. Of course, when its coking plant and the Tula plant are operational, both will be able to consume levels of heavy crude close to Dos Bocas, which is consistent with the structure of crude oil extracted in Mexico: 50.5% heavy, 23.1% light, and 26.4% super-light and condensates (PEMEX, 2025).

In the case of natural gas, the situation in terms of dependence is dramatic, as imports of this energy source, almost entirely from the US, have increased steadily since the beginning of the century. Already in 2015, PEMEX's production met only 59.1% of national consumption, a ratio that did fall to 16.3% in the first quarter of 2025, if fiscal huachicol is not considered.

Given its impact on the oil trade balance and the current account of the balance of payments, the country's self-sufficiency in fertilizers was also proposed. This required PEMEX to produce more ammonia, the raw material for urea, the most widely used and least expensive nitrogen fertilizer sold in the country, although it must be acknowledged that it is highly polluting to both the soil and groundwater. Despite problems with equipment corrosion due to disuse for two decades, leading to the presumption of unaffordability, Pro-Agro's sixth plant, formerly Agronitrogenados, was rehabilitated between 2022 and 2024 at the Cosoleacaque Petrochemical Complex in Minatitlán, Veracruz. It is part of a group of four plants that would be restored to meet national demand, self-sufficiency and the constitutional mandate to provide free fertilizers to small agricultural producers, without intermediaries (Article 27, reformed in December 2024). All this based on the Fertilizers for Well-being program, initiated during AMLO's

administration and reinforced by the following one. The planned investment involves US$375 million and includes, in addition to the four ammonia plants, two urea plants, the rehabilitation of the Lazaro Cardenas plant, and a phosphate rock mine in Baja California Sur.

In practice, production increased by 2.5% between 2015 and 2018, and by 14% between 2018 and 2025, according to preliminary figures, primarily driven by the Cosoleacaque works. Private companies contributed nearly 20% of the 2.15 million tons recorded. Domestic consumption, on the other hand, was much higher. Despite the increase in production, the level of dependence decreased only slightly between 2015 and 2024, from 41.8% to 37.4%. On average, for every ton produced in Mexico, almost two are imported (PEMEX, 2025).

If ammonia production increased as projected starting in 2024, one might wonder what PEMEX did with it. Official statistics suggest that a large portion was exported (traditionally, the two main petrochemical products exported by this company have been ethylene and ammonia). In fact, a 10.7-fold increase in exports of ammonia was registered between 2018 (US$1.77 million) and 2024 (US$18.9 million). Compared to the first four months of 2025, almost US$3.4 million was exported, which when annualized would be US$10.2 million, a figure lower than that of 2024 but almost six times higher than that of 2018 (PEMEX, 2025).

4.4 Taking into account citizens' opinions, including fracking, contracts, and daylight saving time

Public opinion played an important role in several momentous decisions during AMLO's administration, starting with the cancellation of the Texcoco airport. In this regard, it was established that hydrocarbon exploration and exploitation facilities, as well as those related to energy transmission, generation, and distribution, would not be decided unilaterally, nor would they disregard communities' acquired rights to land and other resources. Similarly, it was argued that citizens were unhappy with handing over portions of the national territory and its maritime border to foreigners (mainly related to license contracts, which were equivalent to concessions) for exploitation and hydrocarbon extraction.

Dissenting voices were also heard regarding the installation of towers for wind power generation and the diversion of irrigation water for consumption by thermoelectric plants (as in the case of Huexca, in Yecapixtla, Morelos, whose production remains unreported due to several pending injunctions). In particular, it was argued that the energy sector could not be placed above the interests of these communities, and that the compensations referred to in the 2013-2014 energy reform failed to take into account their historical achievements, such as agrarian reform, or their ancestral roots.

Regarding the reported review of the 111 hydrocarbon exploration and exploitation contracts granted to 33 private international and national oil companies between 2015 and 2018, it was decided that they would be respected since no irregularities were found. These agreements involved companies as large as Exxon Mobil, Chevron, Shell, BP, Total, Equinor, COOC, Statoil, Repsol, ENI, Petrobras and Lukoil, authorized to explore and exploit resources in plays as sensitive as the deep waters of the Gulf of Mexico. In the case of the north-northeast onshore region, considered an extension of the Eagle Ford formation in Texas, principally the Sabinas Basin and partly the Burgos Basin, including the states of Coahuila, Nuevo Leon, Tamaulipas and a considerable portion of Veracruz, with great potential for both shale oil and shale gas, the use of fracking techniques was restricted.

As a result of the 2024-2025 modifications to articles 25, 27 and 28 of the Constitution, it was announced in July 2025 that 11 Mixed Development Allocation titles would be put into operation between PEMEX, which remained unexploited or underexploited its most recent allocations, and national and international private companies. With this, so it was said, the country's oil industry would inject a little more than US$8 billion into exploration and production, and PEMEX would partner with companies such as Carso Energy (Mexico), which would invest US$5 billion in the Ixachi field mentioned above to boost its gas and crude oil production; Woodside Energy (Australia), BP (Great Britain), and Sinopec (China). The reasons given for reorienting the industry in this way were no different from those given by the previous government regarding the service provision, utility sharing, production sharing, and even licensing contracts during 2014-2018: access to private financing without committing public resources,

optimizing investment in exploration and production; improving PEMEX's operational efficiency; accelerating the exploitation of new fields without assuming all the risks; and opening the industry to cutting-edge technology (Gutiérrez-Rodríguez, 2017). Thus, according to the Hydrocarbon Sector Law (DOF, 2025), pre-existing contract modalities were not eliminated, although the State's constitutional right over them and the subsidiary role of private companies were clarified.

In October 2022, a decree issued on January 4, 1996, was reversed. Daylight saving time was established from the first Sunday in April to the last Sunday in October each year, which consisted of setting the clocks forward one hour in the three time zones that cross the national territory. Subsequently, but not simultaneously, the municipalities along the border with the USA and the states of Quintana Roo and Sonora were exempted. The idea stemmed from the need to take advantage of the year's period of greatest sunshine to save an amount of energy equivalent to the annual consumption of the state of Colima and, as an externality associated with globalization, to better synchronize the country's timetables with those of the world's financial and commercial markets, particularly the United States.

In the same vein, arguments were invoked regarding the health problems affecting people, particularly emotional and cardiac issues, due to the implementation of daylight saving time (DST) in 1996, which will be eliminated starting in 2023. All of these actions, perhaps justified for a considerable portion of the population, since they appealed to national sovereignty, among other things, were not justified for energy self-sufficiency, per capita GDP growth, and economic development. Perhaps for this reason, the latter two aspirations, as ingredients of collective well-being, were not accepted in planning documents or official discourse. The idea of happiness was, however.

4.5 Priority of refined products elaboration over crude oil exports

During his campaign, and particularly upon taking office as President of the Republic, AMLO made several remarks regarding the refining industry, which were reflected in the National Refining Plan: i) A new refinery would be built in Dos Bocas, Paraiso, Tabasco, with a processing capacity of 340,000 BPD of crude oil, presumably with a 22-degree API, i.e. Maya, and a cost of US$8 billion. It will begin operations in 2022. ii) The six existing refineries would be modernized with an investment of US$1,300 billion. Iii) With this, by 2022, the crude oil processing capacity of the seven refineries would increase from 1,523,000 BD to 1,863,000 BD, which would produce approximately 781,000 BD of gasoline and 560,000 BD of diesel, more than enough to supply the domestic market and export surpluses. iv) Added to this was the decision, made public in multiple forums and documents, to prioritize refining over crude oil exports.

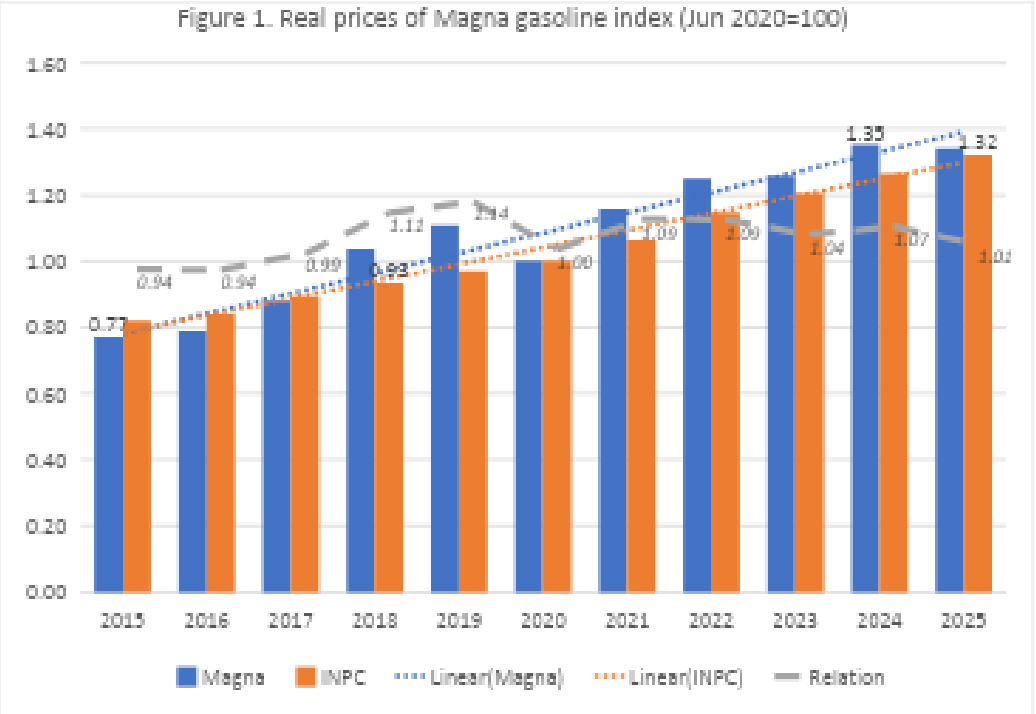
Refined oil production did not increase between December 2015 and April 2025; on the contrary, it decreased from 1.3 MBD in the first month to 332 TBD in the second. Crude oil exports were not eliminated either, as they increased from US$71.3 million in the first month to US$386.1 million in the second. However, there was something positive: PEMEX's trade deficit fell from US$1.183 billion in December 2015 to US$803.8 million in April 2025, which implies that the amount of imported refined products also decreased (PEMEX, 2025). This improvement is in line with the improved performance of the vehicle fleet and the savings effect generated by the rise in the price of fuels and electricity since 2017. Additionally, the impact of private fuel importers who have permits is significant, with most of them supplying their gas stations (38% of the more than 12,000 in the country are not PEMEX franchises). It is worth noting that some may engage in illegal activities, as will be discussed later. As a result of these factors, the value ratio of PEMEX's refined products imports to crude oil exports was reduced from 17.7 in December 2015 to 3.1 in April 2025.

4.6 Constant fuel prices and the fight against fuel theft

The best way to verify whether the principle of keeping fuel prices constant in real terms was respected is to take the most representative gasoline, Magna, and compare its evolution with the National Consumer Price Index (INPC). To do this, an 11-year series is compiled, from 2015 to 2025, taking June 2020 as the base month (1.00), when the world and the country were in the midst of the COVID-19 pandemic. For consistency, the data for each year correspond to the same month. Based on this analysis, Figure 1 shows that in 2018 and 2019, the years following the liberalization of fuel prices (2017) contemplated in the 2014-2015 energy reform, the price of Magna increased 4 percentage points faster in 2018 and 11 points faster in 2019

than the INPC. The trend continued in 2021, when the difference between the Magna price index and the INPC was 6%, and peaked in 2024, the year of the country's general elections, at 7%, as shown by the dashed line in the graph. The trend lines for both variables show the widening of the differential.

Figure 1. Real prices of Magna gasoline index (Jun 2020=100)



Sources: PEMEX (2017); CRE (2024); INEGI (2025a), and PROFECO (2025)

Regarding fuel theft, official figures showed a decrease from an average of 94.7 TBD in the illicit fuel market during the 2013-2018 administration (Table 2) to just 6,000 BD in the first few days of 2019. They saw these activities as the only corruption problem of PEMEX and its relation with society, its service providers, and other groups. With the elimination of 90 TBD stolen from these products, it was proposed that a savings base would be created to finance social programs and even maintain real fuel prices. However, on one hand, the problem rapidly worsened and took on new forms; on the other hand, the costs involved in combating it, perhaps due to failed planning, proved excessive. So, the supposed savings never materialized, and public finances became overwhelmed.

Table 2: Estimation of the illicit market for liquid fuels

Thousand barrels per day average

Year	Producc	Imports	Exports	NAC*	Sales	Imp/CNA	Theft**	Theft/NAC
2013	1251	523	178	1596	1502	32.8	94	5.9
2014	1180	556	196	1540	1428	36.1	112	7.3
2015	1093	635	192	1536	1427	41.3	109	7.1
2016	960	750	179	1531	1467	49	64	4.2
2017	771	893	151	1513	1409	59	104	6.9

2018Jan-Nov	629	916	135	1410	1325	65	85	6
Average	980.7	712.2	171.8	1521	1426.3	47.2	94.7	6.2

* National Apparent Consumption (NAC) = Production + Imports – Exports.
** Theft = NAC – Sales. The calculation implies that the internal market supply (NAC) is larger than the reported sales.
Source: Gutierrez-Rodriguez (2019)

To address the issue of punctures in the pipelines, particularly the one running from the port of Tuxpan, Veracruz, to Tula, Hidalgo, and from there to Azcapotzalco, Mexico City, an urgent acquisition of 571 tanker trucks with the capacity to transport 116.8 thousand barrels of crude oil was ordered without bidding, citing national security concerns. The total reported expenditure for this acquisition was US$85,393,097, resulting in an average price per tanker truck of US$149,550 (Gutierrez-Rodriguez, 2019). The administration and management of these tankers were entrusted to the Ministry of National Defense (SEDENA).

Five years later, the PEMEX General Directorate disclosed that by the beginning of 2019, 637 tanker trucks had been incorporated, with plans to acquire 1,800 more by 2023, bringing the total number to 2,437 units (Romero Oropeza, 2024). This represents a 4.3-fold increase from the initial number in 2019, indicating the obsolescence of the fleet previous to 2019 of tanker trucks. With the investment calculated at the established price per unit, the total expenditure amounted to S$364,453,350, permanently., permanently expanding the transportation capacity to nearly half a million barrels of oil at any moment.

Despite the extraordinary effort to transport hydrocarbons by land, with the consequent costs of road wear and tear and the danger and inconvenience to the rest of those who use them, in addition to the parallel involvement of the army in the guard of the pipelines, which by definition would be underutilized, the number of illegal punctures remained at very high levels. After peaking in 2018 with 14,956 punctures, it declined over the next two years (13,053 in 2019 and 9,132 in 2020). From that point on, they rose again, reaching 12,005 in 2023, as if the strategy to combat huachicol had been abandoned (Barnes de Castro, 2025a). Of course, this trend is not paralleled by the 95% impressive reduction reported in the number of barrels diverted to the illicit market between the peak on December 2, 2018, and January 12, 2019, when it was assured that the problem of pipeline leaks had been solved.

Alongside the persistence of illegal tapping, another long-standing problem worsened. It exploded in the year of the pandemic due to the federal government's assistance to private companies importing fuel and grew again in 2024. This illicit activity was revealed through intelligence work during the first nine months of the new administration (October 2024–June 2015), during which 69,376,918 liters of fuel, equivalent to 1,520 barrels, were seized. These barrels were brought into the country mainly by sea and rail. The figure exceeded the amount seized during the entire previous administration, 46,102,343 liters. However, this seizure represents only a fraction of the total theft and has no parallel with smuggling, which could have reached 30% of the country's gasoline and diesel imports in both 2024 and the first half of 2025. Diesel, whose market price is higher than gasoline, predominates in these illicit activities, while in the US gasoline is more expensive.

According to the US Embassy in Mexico, the cartels send "legalized" crude oil via road and rail tanks or even pipelines from Mexico to Texas. They place it in US refineries for processing and then reintroduce it into Mexico through customs as fuel using falsified documents and front companies. Upon reintroduction, they cross the border without paying the customs duties they would be required to pay because they are disguised with tariff fractions corresponding to automotive oils, lubricants, or alcohols. It should be added that they are generally sold at retail in an unregulated manner (without traceability) at gas stations and even unregulated retail outlets, and they do not pay the Special Tax on Production and Services (IEPS): which is originally paid by the producers and importers and then translated to final consumers. If we take into account that the IEPS represents 25% of the market price of fuels and assume that this is

the only tax evaded, the fiscal damage would have been 140 billion pesos in 2024 (approximately US$7 billion). However, the total damage inflicted on the Tax Administration System (SAT) and PEMEX should include leaks, theft from operating centers, clandestine refining in home plants, and other types of leaks.

4.7 PEMEX's financial recovery

It can hardly be argued that the worsening of PEMEX's financial problems between 2018 and 2024 was the result of poor management of its trade balance or the high level of taxes and duties it directly contributed to the federation. On one hand, the trade balance resulting from its crude oil exports and imports of petroleum products, natural gas, and petrochemicals, transitioned from a deficit of US$-3.384 billion in 2018 to a surplus of US$435 million dollars in 2024. This was the result of a faster reduction in imports compared to exports (-22.6% vs. -12.7%, respectively), which corroborates that during this period, Mexico began an interesting process of energy transition in the transportation sector, although not necessarily in the electricity generation sector, where the share of natural gas (combined cycle plants), primarily imported, continued to grow. This is intended to address the declining gas-to-oil ratio in Mexican Wells, the virtual depletion of important dry gas reserves such as the Sabinas basin in the northern region of the country; and the commitment not to resort to fracking to develop shale gas fields in the north-northeast region.

On the other hand, PEMEX contributes resources directly to the Mexican State in the form of oil revenues. These revenues gave rise to the Mexican Petroleum Fund for Stabilization and Development (FMP), created with the 2013-2014 energy reform. They mainly include the Shared Utility Right (DUC), royalties linked to hydrocarbon exploration and exploitation, state marketer sales, the contractual quota for the exploration phase, and certain royalties (BANXICO, 2025). The calculation of the DUC, which has been by far the most significant contribution to the FMP, is based on the market price multiplied by the barrels of crude oil extracted, from which various costs, expenses, and investments are deducted to establish the amount in pesos to which the royalty rate should be applied. In order to provide PEMEX with sufficient resources to invest in new fields, the Federal Executive ordered the DUC to decline rapidly in recent years: between 2015 and 2018, it was 65%; between 2019 and 2020, it fell to 54%; between 2021 and 2023, it was reduced to 40%, and in 2024, it fell to 30%. This reduction of more than half over the six-year term entailed a loss of revenue of 484 billion pesos (México Evalua, 2025), approximately US$24.2 billion. Starting in 2025, a further adjustment to the system was implemented, as the DUC was substituted with the Oil Right for Well-being, set at 30% for oil and 11.63% for non-associated gas.

In addition to the aforementioned reductions, the SHCP waived PEMEX's deferral of the DUC payment at various times. Additionally, in February 2024, it waived payments corresponding to the last quarter of 2023 and the first month of 2025, and in August 2024, it exempted PEMEX from paying the accumulated balance corresponding to May, June, and July of the previous year. These tax waivers amounted to 506 billion pesos (Mexico Evalua, 2025), some US$25.3 billion. Furthermore, the SHCP made contributions to PEMEX's capital totaling 1,019,172 million pesos, some US$51 billion.

At the same time, PEMEX reported accumulated losses of 1.8 trillion pesos (US$90 billion), generated not only by the ineffectiveness of TRI and the inability of PEP to balance them with its positive balances, but also because in 2024 PEP itself reported net losses of 37,108.8 million pesos (Mexico Evalua, 2025; Barnes de Castro, 2025b), equivalent to US$1,855 million. Likewise, according to its financial statements, PEMEX had accumulated a debt of 4.2 trillion pesos at the end of 2024 (US$210 billion), with the most notable increase in the share of short-term debt, which went from 1.3% of the total in 2018 to 28.8% in 2024. This of course implies enormous financial pressure, not only for the company but also for the federal government, which, having returned its status as a public company, considers them as its own and has also made financial contributions in recent years to help cover their service: at least 92 billion pesos (México Evalua, 2025), equivalents to US$4,600 billion.

Adding the federal government's total support to PEMEX, the total amounts reach 2.1 trillion pesos for the 2019-2024 period (US$105 billion), an average of 350 billion pesos (US$17.5 billion) each year, equivalent to 1.3% of the Gross Domestic Product (GDP), a figure similar to the expenditures linked to the Welfare social programs inaugurated during the AMLO's administration.

This creates the risk that the loss of PEMEX's investment grade, determined by Fitch Ratings and Moody's in April 2020, while Standard and Poor's placed it on a negative perspective, could eventually affect the federal government itself. In other words, while before the 2013-2014 energy reform, PEMEX financially supported the federal government thanks to its international credibility and low debt costs, its credit problems since 2020 have caused the relationship to reverse. Thus, from being an asset to the government until 2018, it progressively became a liability, not only due to the high financial cost of its debt, but also to its excess staff (some 129,500 people), combined with a rapid decline in its production, which positions it as the sizable oil company (it is one of the 20 largest in the world in terms of revenue) with the lowest product per person employed: Each worker produced 9,280 kilowatt-hours of oil equivalent in 2023, which placed the country in 32nd position worldwide. In Latin America, it fell below Guyana, Brazil, Argentina, Ecuador, and Venezuela (Our World in Data, 2025). Given that the company's book value at the end of 2024 was 2.86 trillion pesos, well below the 4.2 trillion debt previously presented, it was objectively bankrupt (Mexico Evalua, 2025). Besides, its documented external debt in dollars alone reached US$96.418 billion at the end of 2024 and US$101.065 billion in the first quarter of 2025. Although this latter level was US$12.162 billion lower than the peak reached in 2020, this is due to the application of an excessively high exchange rate in 2020, owing to the crisis generated by the Covid-19 pandemic.

V. RESULTS AND DISCUSSION

The results of the oil industry's planning exercise implemented during the campaign and the first months of AMLO's administration, which were framed by the ideals of national sovereignty and energy self-sufficiency, seeking to address social demands rather than market dictates, yielded poor results. From a macroeconomic perspective, the economy grew by an average of 0.8% annually, which meant that per capita GDP declined during the six-year term (annual population growth is 1.1% per year, if immigration is not considered). Similarly, inflation was the highest during those years of the 21st century, with an annual average of 5.17%. Meanwhile, formal job creation reached 2,022,877 posts, half of those created during the previous six-year term and a lower figure than the previous two six-year terms, despite the fact that in those years more than 6 million people entered the labor market, implying that two-thirds of them went to informality.

Extensive resources amounting to a yearly average of more than 1.5% of GDP (and continuing to grow) were devoted to social transfers, ensuring that at least one program reached 80% of all families, 30 out of 38.5 million families in the country. Similar amounts were assigned to strengthen PEMEX operations and finances, and at least 1% to infrastructure that is yielding between 15% to 25% of what they should (exact figures are reserved by the State and it has not been informed when they will be disclosed): Dos Bocas refinery, the Tren Maya, the Transisthmian Train, the Mexico-Toluca Train, and the Felipe Angeles Airport, which absorbs the expenditures for the cancellation of the Texcoco Airport. In conjunction, all those expenditures add up to 4% of annual GDP. As a consequence, the Public Sector Borrowing Requirements (PSBR), equivalent to public debt, almost tripled from 2.1% of GDP in 2018 to 5.7% in 2024 (SHCP, 2025).

Meanwhile, all methods of measuring poverty (income, labor, extreme, multidimensional) decreased significantly during the six-year period (INEGI, 2025b). This occurred regardless of the quality of employment, health, public education services, and everyday infrastructure usage (streets, roads, ports, telecommunications, airports, etc.). As Hansen (1974) predicted, providing resources to people through social policy to fulfill the promises of the Mexican Revolution finally became more important than providing quality services and assisting the country in addressing its investment needs for development.

Even historical programs such as targeting the most needed people to address poverty and the National Employment Service, which provided stipends for unemployed people in some regions and supported worker qualification and requalification to increase productivity, were dismissed. Many reforms in strategic sectors were reversed, as well as in the political, judicial, and electoral spheres. Summing up, concerns about day-to-day issues became more important than concerns for the future, and planning ceased to be a significant component of government policy.

Regarding the seven core tasks of the oil policy outlined, only the first, the legal reversal of the 2013-2014 energy reform, whose outcome was

predictable given the overwhelming majority of MORENA and its allied parties in Congress, and the fourth, the consideration of citizens' opinions, including fracking, contracts, and daylight saving time, were fully accomplished. The success of this clearly depended on the government's popularity. We now move on to the five tasks that were not met.

Although an increase in hydrocarbon exploration and production was desired and circumstances demanded, the steps taken seemed designed to achieve the opposite. In this regard, the number of exploration and development wells decreased; the bidding process for blocks was paused; disputes arose with some private companies over the delimitation of the resources that were due to them vis-a-vis PEMEX; no work was done on exploration and exploitation in the deep waters of the Gulf of Mexico, despite the discovery of the Trion field in 2012, and the use of fracking was banned, without which the recovery of shale oil and gas from the north-northeast region of the country, as an extension of the Eagle Ford formation in southern Texas, seems difficult. Additionally, gas condensates were classified as liquid hydrocarbons to cushion the fall in domestic crude oil production, which, like natural gas production, fell in early 2025 to levels not seen since the 1970s. The Quesqui field, discovered in 2019 in Tabasco, and the Ixachi field, discovered in 2017 in Veracruz, played a key role in this. These fields came online during AMLO's administration, contributing 25% to liquid hydrocarbon production and 40% to gas production.

Although the strategy followed to achieve self-sufficiency in refined products and fertilizers made some progress, it also absorbed far more resources than budgeted, without meeting expectations. The three main instruments to achieve this were the construction of a new refinery, the recovery of the productive capacity of the six operating refineries, and the restart of several ammonia production plants to ensure sufficient nitrogen fertilizers. The Dos Bocas refinery, which was expected to enter full operation first in 2022 and then it was postponed to 2024, at a total cost of US$8 billion, only began refining oil at 25% of its capacity in April 2025, at a cumulative cost of $21 billion. The refurbishment of the six existing refineries, particularly to accommodate more crude produced in the country, Maya, was not possible because the coking plants at the Tula and Salina Cruz refineries were not completed. Thus, the fuel oil/gasoline production ratio remained at nearly two-thirds, at a time when fuel oil is viewed as an undesirable byproduct of refining, given its high sulfur content and other harmful substances. Its use for maritime transport was eliminated in accordance with the International Maritime Organization. Likewise, the CFE has begun a process of reducing its use for electricity generation.

Regarding fertilizers, the rehabilitation of the public agro-industry enterprise Pro-Agro, in the Cosoleacaque Petrochemical Complex, was not enough to achieve self-sufficiency. At least three other ammonia plants, two urea plants, the Lázaro Cárdenas plant, and a phosphate rock mine in Baja California Sur must be rehabilitated. Furthermore, while on one hand the objective of self-sufficiency was established and the obligation of the federal government to provide fertilizers free of charge, without intermediaries, to small agricultural producers was included in Article 27 of the Constitution, on the other hand at the end of the six-year term, ammonia exports had to be increased, given the impossibility of producing all the fertilizers internally.

Public opinion played a very important role in several momentous decisions during AMLO's administration, starting with the cancellation of the Texcoco airport. Similarly, it was argued that citizens were unhappy with handing over portions of the national territory and its maritime border to foreigners (mainly related to license contracts, which were equivalent to concessions) for the exploitation and extraction of hydrocarbons. On this basis, not only were the tenders awarded by SENER to these companies during the previous administration reviewed, but the entire bidding process was also suspended from December 2018 onwards. Similarly, the communities' position regarding the installation of facilities for hydrocarbon exploration and exploitation, including fracking, was taken into account. Dissenting voices were also heard regarding the installation of towers for wind power generation and the diversion of irrigation water for consumption by thermoelectric plants (as in the case of Huexca, in Yecapixtla, Morelos, whose production remains unreported due to several pending injunctions). In particular, it was argued that the energy sector could not be placed above the interests of these communities, and that the compensations referred to in the 2013-2014 energy reform failed to take into account their

historical achievements, such as agrarian reform, or their ancestral roots. In the same vein, arguments were invoked regarding the health problems affecting people, particularly emotional and cardiac issues, due to the implementation of daylight saving time (DST) in 1996, which will be eliminated starting in 2023.

All of these actions, perhaps justified for a considerable portion of the population, since they appealed to national sovereignty, among other things, were not justified for energy self-sufficiency, per capita GDP growth, and economic development. Perhaps for this reason, the latter two aspirations, as ingredients of collective well-being, were not accepted in planning documents or official discourse. The idea of happiness was, however.

The priority given to refined fuel production over crude oil exports never materialized. On one hand, the increase in refined fuel production was not consolidated, as Dos Bocas did not begin operations in the planned year, nor were the six existing refineries modernized. Thus, the increase in gasoline production was not felt until 2025. On the other hand, the lower crude oil exports occurred not as a deliberate policy, but because domestic hydrocarbon production showed a steady decline over the seven years reported. What was observed was an improvement in PEMEX's trade balance, which at the end of the period showed positive figures, although this was due to the fact that many fuel imports were made by private companies (gas stations with brands other than PEMEX represent 38% of the total), and to the start of a savings process in the transportation sector thanks to new technology vehicles. Despite these economic and social objectives, the real prices of fuel and fuel theft in its various forms grew year after year, with only a few exceptions. In concrete terms, the price of Magna gasoline increased faster than inflation, with the exception of 2020, the year of the COVID-19 pandemic, when the international price of crude oil slowed, and therefore the price of imported gasoline. Furthermore, the government did not fully implement the IEPS for gasoline and diesel, as it did starting in 2024, when spending on flagship projects, social programs, and support for PEMEX approached 4% of GDP.

Regarding the fight against fuel theft, whose resources were supposed to finance social programs, not only did the theft continue after a reduction during the first two years of the six-year term, but other forms of theft, such as fiscal huachicol, were also discovered. This involves tax evasion through the symbolic payment of customs duties on gasoline, and especially diesel, which is more expensive in the domestic market than diesel, by declaring the product with a substantially lower tariff rate, generally automotive oils, lubricants, or alcohols. Furthermore, they would not be subject to the IEPS. For this reason alone, the government would have lost 140 billion pesos in revenue in 2024. Added to this figure are punctures of gasoline, diesel and gas pipelines; theft from operating centers, mostly refineries; clandestine refining in home plants, and different forms of corruption inside PEMEX and in collusion with certain authorities, contractors and organizations linked to the company.

Far from improving, PEMEX's financial situation worsened during his six-year term, as evidenced by the fact that it lost the investment grade it had enjoyed with the credit rating agencies Fitch Ratings and Moody's. Having ceased to be an EPE and transformed into a public company, many of its problems were automatically passed on to the federal government, which provided ongoing support: it granted exemptions and tax and fee reductions (particularly the DUC), paid part of its debt service, made contributions to its assets, etc. The sum of these expenditures during the six-year term amounted to 2.1 trillion pesos, which, when averaged over the year, represented 1.3% of GDP. Likewise, its debt balance continued to grow; short-term debt now represented nearly a third of the total; maturities were shortened and concentrated in 2025 and 2026; The company's external debt remained close to US$100 billion, and it was unable to honor payments to its suppliers and associated companies, which caused their support for hydrocarbon extraction to decrease. Given that the company's total value at the end of 2024 was 2.86 trillion pesos, well below its 4.2 trillion pesos debt, from an accounting perspective, it was bankrupt, and from being an asset to the government, it became a liability.

VI. CONCLUSIONS

Since the 21st century, PEMEX has been excessively resistant to change. First, its production has fallen from the peak of 3.383 MBD and 4,570 MCFGD in October 2004 to 1.627 MBD and 4,500 MCFGD in April 2025. Second, its reserves have fallen from 18,895 BBCE in 2004 to 8,383 BBOE in

2024. But since in the same years the number of employed people fell from 137,700 to 129,000, the output per person employed fell from 24.6 barrels per day in the first year to 12.6 barrels in the second. Besides, proven reserves decreased from 13 to 8.4 billion barrels of oil equivalent (BBOE) between 2015 and 2024, and although some gas wells were discovered, oil remained the primary focus. By 2024, the reserves/production ratio stood at just 8.7 years.

It is therefore not surprising that the company's external debt increased from US$31.5 billion at the end of 2004 to US$97.632 billion by the end of 2024. With the company's service providers, the accumulated debt was over US$21 billion by the latter period. The government supported the enterprise with different kinds of transfers: operating capital, financial capital, tax reductions, tax deferrals, and others, amounting to 1.3% of GNP per year.

Although the 2013-2014 energy reform faced obstacles, primarily social, due to the significant role that the progressive government of Lazaro Cardenas (1934-1940) granted to the oil and electricity industries when the former was nationalized in 1938 and the latter created in 1937, it was recognized at least since 2005 that times had changed. Without improving PEMEX's operational efficiency, accelerating the exploitation of new fields while assuming only partial risks, and opening the industry to cutting-edge technology, the state enterprise could not guarantee enough hydrocarbons and a promising future for the development of Mexico.

The experiment of the energy reform lasted only four years, from 2015 to 2018, during which many private oil companies, both national and international, acquired the right to explore and exploit 111 land and sea areas through bidding, most of them in consortiums, including PEMEX. As support for the process declined from 2019 onwards, both reserves and production decreased, and the State efforts were concentrated on oil refining, which after significant expenditures yielded some results by the end of the six-year term. For these reasons, in general the oil industry, of which PEMEX represents 95% in terms of production, is in a worse situation in 2025 than in 2018.

The new administration has changed the name of the contracts through which private companies collaborate with PEMEX. They are now called mixed contracts, and the production-sharing, profit-sharing, and licensing contracts, which were the most important during the 2015-2018 administration, have in the short run been omitted. In the new arrangements, PEMEX must be the operator and own at least 40% of the project. Several large private companies, both national and international, have expressed interest in exploring and exploiting areas such as the deepwater Gulf of Mexico, the Burgos Basin, and inland hydrocarbon deposits. However, there is likely to be much negotiation ahead before they decide and be allowed to resume operations.

To achieve growth in the industry, new reserves need to be discovered and developed at a faster rate than extraction, which poses a challenge despite the declining domestic demand for refined products and controlled exports. In this sense, the oil industry, 95% in PEMEX's hands, must be redirected to increase hydrocarbon exploration and production, as well as the utilization rate of installed refinery capacity. Similarly, PEMEX needs to increase its productivity and competitiveness, concentrate on the most important aspects, and reduce its financial pressures with banks, service providers, and the government. Can investors and PEMEX trust energy planning direction to make long-term decisions and achieve these challenges?

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Hidden Narratives in the Creases of Life: A Review of Li Hao's Life Behind Life

Wang Zuyou[δ]

ABSTRACT

A good novelist should be a good psychologist. He understands the reader's psychology and knows how each character in a story would react differently to an event. This game-like process is full of fun and embodies the spirit of play. (Li Hao) Logical coherence, detailed historical context, and unique narrative angles combine to create exquisite stories. Li Hao, as a "story magician" working behind the scenes, continues to draw inspiration from life and infuse it into his literary creations. his works can be seen as an exploration of hidden narratives in the folds of life.

Journal: Boston Research Journal of Social Sciences & Humanities
Keywords: NA
Accepted: 30 October 2025
Published: 15 November 2025
ISSN: Online ISSN: 2834-4863 | Print ISSN: 2834-4855
Language: English
Research ID: 10b40e10-6846-4671-8300-97598c5f3ba7
Type: Peer-Reviewed Research Article (Open Access)

The authors declare that no competing interests exist. The authors contributed equally to this work.

Read Online: https://rebrand.ly/csffznd

I. "NON-EVERYDAY" CREATION

Li Hao's short story collection Life Behind Life compiles his works from 2020, including Life Behind Life, Absurd Novel, Love Novel, Autumn Frenzy, The Mother Who Releases the Eagle, Story Café, Shadow Warrior, Wooden Boat and River, and Prajā's Last Breakfast. The eponymous short story unfolds the Oriental image of the "father" as a life bearer, depicting the silent burden of men under family and societal pressures. The protagonist externalises his 委屈 and burdens into "warm lies" for his family, creating a paradoxical identity of "bearer" and "liar". The story uses magical realism in everyday details (like "neural extension" of plotlines) to reveal the psychological struggles beneath the surface of life. Li Hao's writing centres on intellectual narrative and existential exploration, with the following dimensions:

A. Thematic Focus: Existential Dilemmas and Human Exploration

Li Hao's writing carries a "singer-like" loneliness, with a touch of compassion for modern people's existential struggles in its "non-everyday" nature. His works often revolve around existentialist themes like survival and death, fate and chance. He digs into the mysteries of human existence like a

"mole", especially focusing on intellectuals' struggles and introspection in wars and power struggles.

I've been teaching "Shadow Warrior" for three years or more. Actually, with a little calculation, I could accurately say how long I've been in the Training Cave, but I don't want to calculate or even resist it. I deliberately avoid thinking about "time". Time, for me and our Shadow Warriors, is meaningless. Our "days" are not of a uniform length; it depends entirely on the training content and specific needs. Sometimes, a Shadow Warrior must lie still in the snow, adjusting his breathing and heartbeat, merging with the snow and rocks until his "day" ends, when grass has sprouted and azaleas cover the hillside. Moreover, for confidentiality, many Shadow Warrior trainings are conducted in the Training Cave, where all time is the flickering of lights and torches, with no distinction between morning, dusk, noon, or night. All time is the same, so there's no need to count it. (89)

The extreme situation of the "Shadow Warrior" reveals the complexity and absurdity of human nature. He rejects "lighthearted drunkenness", using "heaviness" to counterbalance the weightlessness of the times. "In his so-called 'interests' that consume a lot of his time and energy, how much is an excuse, how much is a cover? Why has he been delaying revealing his cards? Is it because he also feels fear or regret?" (15) Through the "father" image, the author questions the entanglement of history, authority, and individual responsibility.

B. Narrative Structure: Deconstruction and Reconstruction of the Everyday

Li Hao constructs a highly deceptive "non-everyday" everyday picture through family members' perspectives. The father's mundane behaviors like getting up early to cook, fishing, and swatting flies are woven into a seemingly impenetrable "web of life". This narrative strategy parallels Kafka's The Metamorphosis—when Gregor Samsa turns into a cockroach, his family maintains its daily routine until the breakdown. Li Hao's uniqueness lies in completely hiding the "abnormal" within the "normal": the father's fishing "addiction" becomes a smokescreen to cover the truth, and even his uncle's "nonsense" becomes a tool for complicity. This structure forces readers to find answers in the crack between "life" and "life behind", using a "belated" narrative structure to deconstruct the everyday, like discovering hidden writing in the creases of an old photo. This technique echoes Kafka's Metamorphosis but emphasises "suspending morality"—by switching between fiction and reality, it pushes characters out of moral judgment, showing the multifaceted nature of human nature.

C. Language Style: Ironic Coldness and Poetic Metaphor

His texts are known for ironic coldness and dense metaphors. Li Hao's language is full of ironic coldness. The mother's "endless" daily complaints and the father's "repetitive" drunk words deconstruct "family conversations". His uncle's "nonsense" and the mother's "rebuttal" become a battleground of power discourse. This language style keeps the text in tension between surface narrative and deep truth, forcing readers to find traces of "new occurrences" in the musty smell of "old days". The father's "performance" and "violence" in swatting flies, the functional reversal of the erhu and fishing rod, etc., are given dual symbolic meanings, becoming micro-metaphors of power relationships. This language style is both restrained and full of tension, like "hidden writing in the creases of an old photo", requiring readers to decode it repeatedly.

In the postscript to Life Behind Life, Li Hao wrote: "In this story collection, I tried to make each writing have different dimensions, different presentations and questions. I don't want them to have self-repeating parts." He has proven this with his actual works.

II. "DUALITY" OF DETAILS: METAPHORICAL SYSTEM OF EVERYDAY OBJECTS

Repeated details in the novel are endowed with dual meanings:

A. Fish and Fishing:

The detail of the father "plundering" his uncle's fishing gear (rods, floats, hooks) suggests an attempt to control life under a guise. The overcrowded fish jar, "overflowing with fish," metaphorically represents the suppressed tension within family relationships. The contrast between the uncle's "bait theory" and the father's "impatience" becomes a microcosmic metaphor of power dynamics. The father's sudden obsession with fishing,influenced by uncle's hobby at surface level, hid narrative trickery in fact.

The "Addiction" of Fishing: The father "plundering" his uncle's fishing gear and declaring "we'll catch our own fish from now on" is less about a passion for fishing than a compensation for a sense of the control of life. By "making his own fishing gear," he transforms "passive acceptance" into "active creation," attempting to dominate the family power structure. The Transfer of "Addiction": The paradox between the father's "non-addiction" to erhu (a two-stringed instrument) and his "addiction" to fishing highlights a shift. Erhu symbolizes "responsibility absence" (going to the brick factory), while fishing serves as an excuse for "habitual absence." The erhu and fishing rod become keys to deconstruct the role of family, as the father uses a "new hobby" to shift his gaze from old life, masking anxiety with "addiction." Metaphor: The "addiction" to fishing is the father's struggle for control over life, while "making his own fishing gear" is his attempt to rebuild order in the family. This "addiction transfer" is a microcosm of power game.

B. The Scene of the Father Swatting Flies:

One of the most tension-filled scenes in the novel. "Performative": The father's "meticulous and detailed" swatting of flies, as if "each swing must be calculated for route, speed, and force," contrasts with the mother's mocking "fiddling." This "performative" attempt to cover up insecurity with a "perfect" act exposes his inner turmoil.

"Violence": The father "uses full force" to swat the flies, causing "the two flies that had just landed to be reduced to a bloody pulp, along with a section of fish intestines that also became blurred." This violence is not only a "punishment" for the flies but also an outlet for the loss of control in life. The "blurring" of the fish intestines overlaps with the flies being "reduced to a bloody pulp," suggesting the invisibility of the truth—the father attempts to conceal the "life behind life" through violence.

Metaphor: The "performative" and "violent" act of swatting flies represents the father's resistance and compromise within the family power structure. He tries to maintain superficial harmony through a "perfect" performance, while violence reveals his inner anxiety.

C. Mother's "Endless Talk" and "Complicit Silence"

The mother's tolerance of the father's "fishing" appears as "ceding power" but is actually a "complicit silence." "Endless talk": At the dinner table, the mother "endlessly" talks about trivial matters like nails, "Little Fatty," and the wonton shop, trying to mask the abnormal with the mundane. Her tolerance of the father's "fishing" is a "complicit silence"—she maintains superficial harmony through "endless talk," while the "silence" reveals her fear of the "life behind life."

Metaphor: The mother's "endless talk" and "complicit silence" are a microcosm of the family power structure. "Complicit silence": Her emphasis on the uncle being "worth the price" exposes the utilitarian logic in family relationships. She upholds family stability—superficial harmony—through "complicit silence," but the "silence" also reveals her powerlessness, even fear, toward the "life behind life."

D. Father's "Craftsmanship" Spirit

The father's sigh, "If a worker wants to do his work well, he must first sharpen his tools," is one of the most philosophical details in the novel.

"Craftsmanship spirit": By "making fishing gear himself," the father attempts to restore order in the family. This "craftsmanship spirit" is, in reality, his struggle to regain control over life. He tries to maintain superficial harmony through a "perfect" performance, but his "craftsmanship spirit" exposes his inner anxiety.

Metaphor of "sharpening his tools": His sigh about "sharpening his tools" suggests his attempt to control life through "tools." His "craftsmanship spirit" is a microcosm of the family power structure. The conflict between this "instrumental rationality" and "emotional rationality" is the central contradiction in the novel—the father tries to stabilise the family through "tools," while "emotion" reveals his fear of the "life behind life."

Metaphor: He attempts to control life through "tools," but "emotion" exposes his fear of the "life behind life."

Li Hao, through the "duality" of details (e.g., the "addiction" and "transfer" of fishing, the "performative" and "violent" act of swatting flies), constructs a tense microcosm of the family, like a "mirror" of the family power structure.

The mother's tolerance of the father's "fishing" appears as "ceding power" but is actually a "complicit silence." The modern family evolves into a more concealed game—the father restores order by "making fishing gear himself," the mother competes for discursive power through "endless talk," and the

children are forced to become witnesses to this power struggle. Her emphasis on the uncle being "worth the price" exposes the utilitarian logic in family relationships. The father's "craftsmanship spirit" is less about an obsession with fishing and more about a pathological pursuit of "control"—by making his own fishing gear, he attempts to restore order in an out-of-control life. This power struggle reaches its climax in the sigh of "one person, one truth": when the father gazes at the fish tank, he may be regarding family members as "observable objects." Li Hao admits: "The 'father' is, to me, a uniform, a symbol—it symbolises strength, authority, and power, the overarching figure of 'patriarchy,' everything that lies behind this power, and a kind of Eastern way of thinking..."

III. CONCEPT OF TIME: THE "FOLDS" OF LINEAR TIME

Li Hao constructs a unique "folded temporality" in Life Behind Life through nonlinear narrative structures and alienated treatment of everyday time. The father's "habitual absence" on Sundays, juxtaposed with his earlier "dutiful absence" at the brick factory, forms a time-based montage. This echoes Proust's "involuntary memory"—the "mildew" scent of past dawns becomes a catalyst for belated realisation. Crucially, the father's "pretended" duration creates a temporal gap with the family's "afterthought," suspending "life behind life" as a spectral presence in the text's shadows. Core Features of Li Hao's Temporality:

A. Time as an "Unfinished Puzzle"

The story collection fragments time into "slices of life" via nested narratives and shifting perspectives (e.g., alternating child/adult views). In the eponymous story, rituals like fishing and swatting flies turn time into "repeatedly folded pages," masking historical fractures beneath surface calm. Unlike Wang Meng's "time as flowing water," Li emphasizes time's suspended nature—truths emerge belatedly, requiring readers to piece together fragments.

B. Alienated Everyday Time as Power Metaphor

Li transforms mundane time (e.g., the "performative" duration of swatting flies) into a micro-theater of power relations. Time becomes an "elastic entity" stretched or compressed, as seen in Autumn Busyness, where agricultural repetition clashes with inner turmoil, revealing modernity's erosion of natural time. Similar to A Lai's "spatialized time," Li focuses on individuals' passivity under temporal violence.

C. Existential Time: Cycles and Breaks

Repetitive scenes (e.g., cyclical dialogues in A Story of Café) imply temporal entrapment, while "exotic imaginings" (e.g., fictional geography in Wooden Boats and Rivers) break cycles. Time holds equal weight to plot and character, but Li's escape is not Forsterian linear redemption—it unfolds through intellectual writing (e.g., nested stories) to carve fissures in the temporal maze.

D. Festive Time as Counterpoint

Though festivals are absent, Li's exploration of "everyday time" mirrors their function as "time variations." The father's "ritualized" swatting parallels festivals' "exceptionalism," but while the latter evokes collective effervescence, the former exposes individual absurdity.

Li Hao's temporality merges existentialism and postmodern narrative: time is both a "folded enigma" and a site of power discipline, ultimately leading to "life behind life"—a realm of eternal questioning, devoid of answers.

In Life Behind Life, the portrayal of the father as a bearer of life's burdens resonates widely with readers. The "liar's paradox"—where he conceals the truth to preserve familial warmth—is praised as "a portrayal of Eastern family dynamics that cuts to the bone." Li Hao's writing embodies a tension between intellect and poetic sensibility: he dismantles life with the precision of a "craftsman" while probing human nature with the depth of a "philosopher," ultimately crafting what he calls an "absurdist novel, a love story."

By treating life as an "unfinished puzzle," Life Behind Life ultimately unfolds as a parable about the limits of cognition. The success of the father's "pretense" stems not only from his masterful performance but also from the family's habitual reliance on the "everyday." Through this microscopic universe of domesticity, Li Hao exposes a shared modern predicament: we (as Seamus Heaney wrote, "weigh so light in the balance") perpetually navigate existence through "belated realization," failing to truly perceive the "life behind life." This state of unresolved inquiry may, in fact, constitute the novel's most profound truth—inviting readers to

close the book yet continue scrutinising the folds of their own lives, seeking anomalies obscured by the veneer of "normalcy."

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RESEARCH ARTICLE BY BOSTON RESEARCH JOURNALS, UNITED STATES OF AMERICA

OPEN ACCESS

The Role of the Dot in Handwriting Computation: A Cognitive Linguistic Perspective on Arabic Handwriting Recognition

Labidi Bouabdallah[δ]

ABSTRACT

Arabic handwriting has faced several challenges throughout its historical journey. First, its morphological problems were overcome through 'Abu l-'Aswad's endeavors. Then, with the efforts of Nasr bin 'āsim and Yahya bin Ya'mur, the closure of its graphic sign system was addressed fulfilling its linguistic functions. Next, through the reforms of 'Al-farāhīdī its coding was completed. In addition to these achievements that resolved the phonological and semantic issues in developing the graphemes of the handwriting system, Ibn Muqla introduced a new challenge on the aesthetic aspect of the letter. By following strict rules that established the aesthetic proportions of each Arabic letter and its subordinate elements according to each type of font, the dot became a geographical unit of measurement. This approach was endorsed by those who came after him, such as 'Ibn 'Al-Bawwāb and Yāqūt 'al-Musta'simī. However, in the modern era, Arabic handwriting presents us with a new challenge, as it has become an integral part of the electronic, digital, and computer communication structures, and solutions for the automatic recognition of Arabic graphemes. Despite the existing efforts in many laboratories and research institutions, the subject raises problems such as the formation of Arabic letters, their design and construction, the capabilities of automatic recognition, and the need for faster letters readability.

Journal: Boston Research Journal of Social Sciences & Humanities
Keywords: Arabic handwriting, automatic recognition, language computing, dot.
Accepted: 28 October 2025
Published: 15 November 2025
ISSN: Online ISSN: 2834-4863 | Print ISSN: 2834-4855
Language: English
Research ID: 570bae60-a447-4d36-a0ca-80f702edfba4
Type: Peer-Reviewed Research Article (Open Access)

The authors declare that no competing interests exist. The authors contributed equally to this work.

Read Online: https://rebrand.ly/4o2208z

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I. INTRODUCTION

Arabic writing authentically illustrates linguistic sounds through a system of signs organised in multiple levels. Each level aligns with a spoken language aspect, beginning with the phonetic level linked to graphemes, progressing to the lexical level associated with words, and culminating with the syntactic level related to the line.

It is true that writing and speech share the same objective and systematic aspects, as well as systems and structures. They fulfil the basic function of language — communication — and are both subject to scientific research methods. However, there are also fundamental differences between writing and speech, which make writing a distinct form of communication. Consequently, the study of writing encompasses a variety of formal and pragmatic topics, including its systems, structures and textures.

In line with the requirements of the times, contemporary linguists have chosen the field of computer research. This discipline uses computer systems to understand human language and simulate human intelligence (Rashwān & al-Muʿtazz Billāh, 2019, p. 17). It also involves studying linguistic codes and processing them automatically using programs, applications and methods developed in the field of artificial intelligence for dealing with data through investigation, extrapolation, identification, analysis and processing. Writing in its various forms is one of the processes influenced by recognition oriented towards human cognitive stages, with the aim of mastering mental processes to produce, understand, and perceive language (Ḍabʿī, 2022, p. 119).

This presents us with the problem of the extent to which the elements of the calligraphic structure are recognised and understood in order to clarify the intended connotations.

The present research attempts to answer the following questions:

1. What are the existing problems in recognising Arabic writing?
2. What methodological, linguistic and cognitive solutions can be suggested to overcome these problems?
3. In what ways can the work of calligraphers such as Ibn Muqla and Ibn al-Bawab contribute to establishing standard parameters for Arabic letters that facilitate their computerisation and integration into automated systems for communication purposes?

The main objectives of this study are to:

1. Identify problems related to the Arabic handwriting system, including its technical, aesthetic and cognitive characteristics;
2. Link the aesthetic and mechanical design aspects of Arabic letters according to the mechanisms of visual and cognitive letter recognition;
3. Highlight the importance of Ibn Muqla's approach to letter design when it comes to solving problems relating to the computation of Arabic letters.- propose practical solutions to address issues relating to the automatic recognition of Arabic handwriting.

1.1 Conceptual Framework

Technical and computer research has significantly advanced in terms of tackling the challenges of natural languages, with its focus on adapting to contemporary demands and aligning with developments across various fields. It is assumed that the existing problems in Arabic handwriting will be solved by applying the most effective and appropriate solutions to its calligraphic structure. Interest in studying Arabic calligraphy in terms of its structure, function, aesthetics and grammar goes back more than 14 centuries. Therefore, the current research assumes that finding solutions to the problem of recognition in Arabic handwriting will primarily depend on the characteristics of Arabic handwriting and the nature of its components. Computer technologies and programs will then be used because they are designed to support these characteristics.

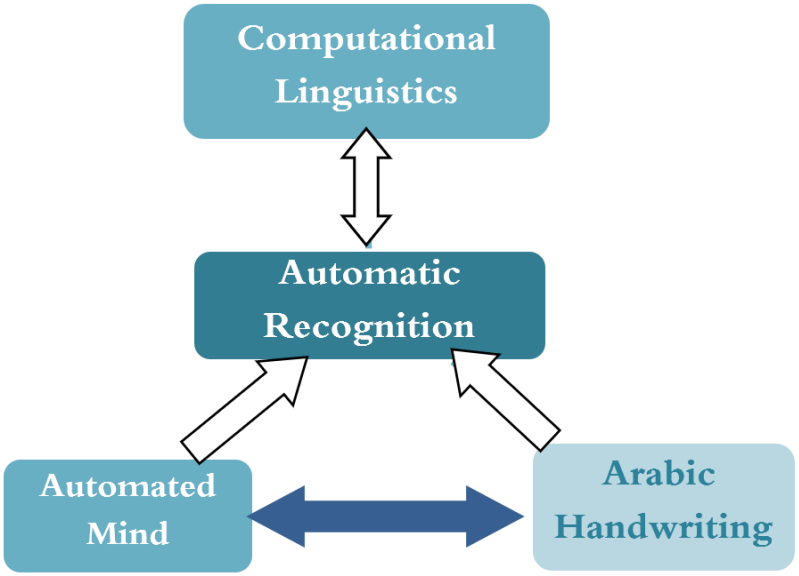


Figure 1: The status of automatic recognition of Arabic handwriting (designed by the author)

All elements of Arabic handwriting, including all forms of graphemes known as allographs, represent a corpus for studying the subject, since each element has a distinctive connotation and is subject to the substitutional and syntactic relations, as are phonemes. The difference is that graphemes function visually (visually perceived), while phonemes exist acoustically (acoustically perceived).

The present study examines the structure of Arabic handwriting by analyzing the identity of letters and graphic syllables and the connotations they provide to human and machine readers, aided by the ontological and geometric presentation of Arabic letters within a uniquely defined structure of Arabic handwriting.

The research addresses one of the challenges in computer recognition of Arabic handwriting, encompassing its graphical, structural, and functional characteristics. Despite ongoing efforts by individuals and companies worldwide to automate and computerise this process employing various mechanisms and approaches, further development is needed. A comprehensive recognition of all elements of Arabic handwriting (including similar letters and grammatical marks, etc.) has not yet been achieved, highlighting that the architecture of Arabic letters has not been fully comprehended.

II. LITERATURE REVIEW

The linguistic problems addressed by computational linguistics are many, including those related to the subject of automatic recognition of Arabic handwriting. Bahashwan and Abu-Bakar (2015) addressed the issue of automatically recognising handwritten Arabic characters without an internet connection. They concluded by proposing an effective algorithm for this purpose. The derivation of character features was from spatial and curved domains, while the structural features were derived from spatial domains. This feature vector is used to train the classifier on the recognition task; the proposed method revealed a promising result in terms of recognition rate, with an average accuracy rate of 90.3% (Bahashwan & Abu-Bakar, 2015).

Benbakreti et al. (2020) demonstrated the effectiveness of using CNN's offline handwritten Arabic word recognition software, which allows for managing large inputs without a pre-processing or feature extraction phase. It performs these operations by summarising the image features during the re-entry phase. The study showed a significant improvement in classification time, and the identification rate was 97.96 % (Benbakreti et al., 2020).

Ibn Jallul (2021) dealt with the stages of digitising fonts. The introductory stage involves the automatic identification of Arabic handwriting from a purely automatic perspective, whether in the

direct (offline) or indirect (online) system. This is followed by the segmentation stage, the stage of extracting features, and finally the classification stage, also known as the identification stage.

The author of this study does not claim that it is the first to address the topic of automatic handwriting recognition, as previous studies have already established its relevance. However, the limitations of previous research should be noted.

Firstly, these studies took a purely technical approach to the topic, failing to link it to the nature of the writing system or the cognitive and functional aspects associated with writing as a human phenomenon, as well as a neuro-motor, linguistic, educational and graphological process. These aspects can be utilised during the automated and digital processing of graphic structures, positively affecting the computational side of various font styles.

Secondly, previous studies were limited to intentional sampling in order to identify algorithms that control the automatic identification process. This perpetuates the problem, given that the number of typical Arabic font types may reach 108 (Rougab, 2019). The number of communicative fonts is equal to the number of individuals whose graphological features are distinct. This requires identification solutions that are characterised by the highest levels of validity and reliability for all types of Arabic handwriting, without exception.

Finally, the failure of previous studies to develop comprehensive algorithms for all typographic and handwritten Arabic fonts has created a clear knowledge and computational gap between research findings from computational applied linguistics and technical engineering using logical disciplines such as mathematics. According to the International Applied Linguistics Society, these two research areas are complementary. The current research aims to bridge this gap.

2.1 Definitions

Arabic handwriting is the structure of graphemes represented by phonemes (Bouabdallah, 2007), from which words are formed. Semantic sentences are then constructed from these words, adhering to the spelling, semantic, syntactic, aesthetic, and perceptual rules developed by linguists and calligraphers, which are followed by their successors to this day.

Automatic recognition involves mathematical algorithms and automated processes that simulate human perception, aiming to identify patterns, perceptions, and external stimuli such as sounds, shapes, colours, and Arabic letters. These algorithms help distinguish the unique characteristics of each letter, word, or line from others.

Language computing encompasses processes wherein computers analyse aspects of human language, including word processing, spoken speech, and images (Rashwan et al., 2019).

The dot is the mark made by a pen on paper or another surface, where its length and width are equal, forming a square or rhombus shape.

III. ARABIC HANDWRITING, ITS FUNCTIONS AND LINGUISTIC CHARACTERISTICS

3.1 Functions of handwriting

These functions can be regarded as the specific characteristics of any means of communication, describing handwriting as that which performs the communicative function of spoken language. In addition to functions identified by graphologists and grammatologists, linguists have largely elaborated on handwriting functions, including the following (Olivaux, 1991):

3.1.1 Instrumental function

The most important function of calligraphy is the instrumental function, which stabilises thought or speech, transforms it, and communicates it. With this characteristic, it becomes an indispensable or irreplaceable means or instrument.

3.1.2 Relational function

The method of conversation, expression, and communication is crucial for each individual, and handwriting holds similar significance. The relational function indicates that handwriting must be readable and understandable, accepted by the recipient, and perhaps even liked (Bouabdallah, 2014), as shown in Table 1.

Table 1: The relationship of handwriting to various levels and values (Bouabdallah, 2020)

Level	Nature	Value	Objective
Graphical	Readable	Graphic	Inductive
Semantic	Understandable	Semantic	Clarity of meaning
Linguistic	Acceptable	Linguistic	Communication
Aesthetic	Loved	Aesthetic	Being fun

3.1.3 Personal perception function

The graphic structures differ from person to person; some are very present, seeking meaning, while others attempt to compensate for their shortcomings in handwriting by distorting calligraphic models and giving the calligraphic structure an aesthetic tinge. This creates an aspect of coverage or serves as a mask, resulting in handwriting that carries minimal spontaneity and the true value of what it conveys (Olivaux, 1991).

In order to fulfil these three functions — instrumental, relational and personal perception — it is essential to consider the following elements: the sender and receiver; the calligraphic effect; the criteria adopted for formation; and the mode of communication. These elements define the characteristics of the calligraphy phenomenon, as described in the subsequent sections (Achard, 1988).

3.2 Characteristics of handwriting

During daily dialogue, the two parties, the utterer and the recipient, will have questions and answers between them; these linguistic expressions can be verb or nominal sentences, linguistic marks, phonetic connotations, gestures by hand or face, and so on.

The rhythm of handwriting relates to the slowness and speed of calligraphic production, which influences the control of graphic patterns and units, causing them to vary from person to person.

The presence of the handwritten traceability distinguishes the handwriting process from that of speech as, contrary to what linguists believe, handwriting exhibits notably standardised morphological characteristics. However, speech may exhibit the same characteristics in some circumstances.

The elements of the handwriting structure can be summarised as follows: calligraphic icon, calligraphic unit (grapheme), letter, space and time, whiteness (vacuum), blackness, punctuation, and line (Al Magri, 1991).

All these elements contribute to constructing a formal pattern, which must be considered when designing handwriting elements. The calligraphic icon, which may represent punctuation marks or the stroke of a pen, is important in identifying phrases and, consequently, understanding the overall meaning.

3.3 Arabic handwriting as a topic for computing, artificial intelligence and automated processing

In this context, we do not need to distinguish between the three terms—computing, artificial intelligence, and automated processing—as handwriting (typing or manual) is equally impacted by all three concepts, provided it meets the objective of transforming the linguistic system into one governed by mathematical algorithms, computer processes, and machine cognition, along with all related digital intricacies. Our primary focus here is on the specific criteria of Arabic handwriting, particularly those connected to writing.

3.3.1 Psychological Criteria

Psychological criteria relate to the graphological aspect, which starts from the psychoanalysis of linear elements, to reach the derivation of the specifications of handwriting activity, in addition to considering the mental connections (motor and cognitive) during the handwriting activity, the most prominent of which are concentration and attention. This control affects handwriting activity through the control of the handwriting tool, the handwriting swiftness, the pressure ratio on the sheet, the perception of

graphemes (form and significance), the continuity in writing, and the method of linking the letters.

3.3.2 Technical Criteria

The artistic character of Arabic handwriting and the nature of its geometric forms express aesthetic aspects rarely found in another linear system. This is evidenced by its use in the decoration of mosques and homes. The sensation in Arabic handwriting is not only the consistency or composition of the lines; the angles and extensions help to distribute the lighting and the direction of sight in the painting, so that it becomes a total and inseparable compound (Al-Kurdi, 1982, p. 46). In addition, it is considered an inspiration for many artistic ideas in letter paintings.

3.3.3 Electronic Criteria

Arabic letters are a linear translation of linguistic sounds in graphic form. They are represented as automatically processed images governed by electronic (digital) controls. An image is a group of consecutive dots of different dimensions that represent certain linear shapes forming a physical volume containing light rays or electronic analogies. The dots may also represent a phrase with mathematical numbers (digital image). The image has two spatial variables, (x, z), which measure the degree of light density in the two rays. The following equations (Bollon et al., 1995, p. 8) can be used to represent this:

$$M = H2\text{-}H$$

$$(X, Z) - M (X, Z)$$

$$Y = M (X, Z)$$

Given that H is a real numbers set containing (X) and (Z).

Thus, image (Y) is a continuous two-dimensional function in Y=M (X, Z), so that M = the value of the space intensity at the dot (X, Z).

From the above, handwriting can be considered a physical movement, carrying a linear connotation within a multidimensional space.

3.3.4 Athletic Criteria

Arabic letters are shapes that bear the characteristics of geometric images. They are parts of a circle, a triangle, or a straight line, which led to the emergence of mathematical calligraphers who attempted to establish mathematical rules for Arabic handwriting, relying on mathematical standards such as length, width, and curvature. Undoubtedly, this geometric mathematical dimension of Arabic handwriting has preserved the forms of letters from distortion and various geographical deviations. It resembles meters in Arabic poetry or the laws and proportions governing astronomical phenomena. Additionally, computers can utilise these rules in the automatic identification processing.

3.3.5 Spelling Criteria

Spelling criteria consist of rules dictating the correct drawing of the shapes of linear units (graphemes) in their original positions and locations, as stipulated by linguists and graphologists. The importance of this rule lies in the fact that learning any form of writing, including Arabic handwriting, must first and foremost mind the correct spelling for drawing letters, including the rules of writing the hamza (the letter: a'), the two types of ta', and words in which letters are added or omitted (Baqshish, 2000; Ibrahim, 1998). It is also important to understand what should be connected and what should be separated, such as: innama (indeed), inna ma (indeed + relative pronoun: that which), and haithuma' (whenever) and haithuma' (wherever), as well as other matters related to dots and shapes (Wali 1985, p.57).

3.3.6 Morphological Criteria

These criteria relate to all morphological phenomena, such as substitution, reasoning, inversion, addition, omission, and various changes in the structure of the word.

3.3.7 Grammatical Criteria

The grammatical criteria are considered one of the most important standards in relation to the word system, as they determine the function of each linear unit and adjust its form at the structural level. According to Tammam (2021, p. 178): 'Arabic grammar comprises a range of general grammatical meanings, which are referred to as sentences and methods, as well as a set of relationships that link private grammatical meanings, such as subjects and objects, and public grammatical meanings,

such as general word meanings, until the desired statement is produced.' (Tammam, 2021, p. 178)

Despite this importance, we cannot separate this control from the morphological officer because grammar has diverse meanings from pure morphological structures (the different structures of words), as follows.

Figure 2: The role of grammar rules in understanding linear units (designed by the author)

3.3.8 Semantic Criteria

Making letters in terms of their drawing, their interdependence, and their consistency with each other has an external value for a semantic work in itself. Once we see the shape of a letter (dāl), we realise that it is a linear symbol for a sound (meaning), as well as punctuation marks, which are considered, and this applies to all elements of the graphical structure.

3.3.9 Cognitive Criteria

By describing the letters as forms available for readability according to the stages shown in

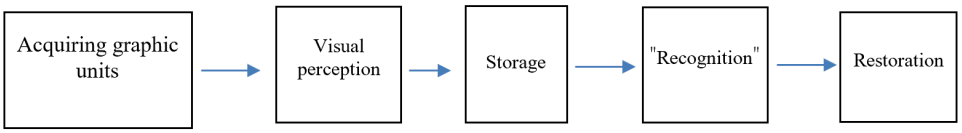


Figure 3: The cognitive stages of the handwriting process (designed by the author)

3.3.10 Geometric Criteria

Geometric criteria are what this research suggests as the foundation on which the shapes of all letters are designed. Their proportions are determined, which the calligraphers demonstrate as the aesthetic of the letters within the linear plate. Based on those lines, programs and algorithms were developed for most standard computer fonts, such as Traditional Arabic, Arabic Transparent, Simplified Arabic, Tajawal, and Sakkal Majalla.

IV. AUTOMATIC IDENTIFICATION, ITS FORMS AND MECHANISMS

It is clear that all processes in a computer (the electronic mind) are simulations of the human mind, and all concepts related to mental activity can be achieved through mathematical algorithms and logical applications. This requires thoroughly representing those concepts and their related mechanisms because any failure to use these mechanisms cannot be compensated for by algorithms; they are the plan that leads us to our predetermined goals. “Identification” is one of the concepts related to automatic identification; it is a feature used by the human mind during cognitive processes. It is the same concept employed in computing activities. It can even be said that what applies to the human mind’s recognition process is reflected in engineering perceptions and technical applications.

4.1 Formula concept

A formula is defined as a coherent, regular unit of a set of interacting parts. One of its prominent characteristics is that it is not merely the sum of the parts stacked or grouped. Rather, these parts are interactive, affect each other, and are related to each other.

Thus, a formula possesses characteristics that extend beyond those of the individual parts. The geometric square is a formula but has qualities that do not exist separately in each of its four sides (ʿĪsawī, 1993).

The formula gives the parts their meaning and characteristics because the parts do not have

absolute qualities or functions. The length of the straight line varies according to the formula in which the direction of the arrowhead is attached to the end of it; the straight line in (a) appears shorter than in (b), although they are equal.

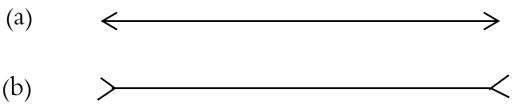


Figure 4: Deception in the length of the straight line

This is due to the direction of the arrowhead in each. This phenomenon is known as the illusion of the visual senses, so that the shape can become a ground, and the ground can become a shape (ʿĪsawī, 1993) as follows:

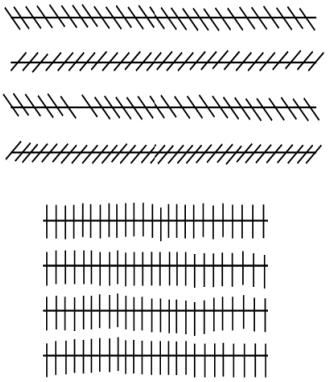


Figure. 5: Deceiving the senses (ʿĪsawī, 1993)

What concerns us in the field of formulas in this research are letters as forms and their relationships with model formulas. These formulas possess spatial characteristics, often represented on paper, a blackboard, or similar surfaces. On the other hand, we consider the relationship between these formulas and the writer's perception, as well as the computer writer's perception of them.

4.2 Linear units

What explains the subjective view in the identification process of these letters is what has already been mentioned: the number of lines corresponds to the number of people. Therefore, we will attempt to examine the typical image of the Arabic letters and monitor the relational interactions among the various linear icons forming the graphical structure and the reflections of known geometric shapes on these graphical units. Then, we can compare the two shapes, the model and the personal:

Table 2: Relationship of the Arabic graphemes to some geometric shapes (typical vision)

Figure	Bookmark	Graphical units bearing the figure
.	Dot	،ب ج، خ، ذ، ز، ض، ظ، غ، ف
..	2 dots	ت، ق، ي، ة
\	Three dots	ث، ش
ا	Vertical Straight	ا، ط، ظ، ك، ل، لـ م
ب	Part of a rectangle	ب، ت، ث، ف
>	Part of a triangle	جـ، حـ، خـ، د، ذ
^		^ (ثلاث نقط)
		ك
	Part of a rectangle	
ـ	.	(شدّة)ّ
		سـ – شـ
°	Small circle	ة، فـ، قـ، هـ
○	Part of a small circle	(عـ، غـ، ي، ء (همزة
	Arc of a circle	ر، ز، و
⌒	Part of a large circle	خ، ص، ض، غ، ق ل، ن، ي
○	Circle	o

○	Semi-circle	ص، ض، ط، ظ
||	Two parallel lines	الـ لـاــ ، طا، ظا
_	Stroke of a pen (before letter)	جميع الحروف عدا ء)
_	Stroke of a pen (after letter)	جميع الحروف عدا (ا، د، ذ، ر، ز، و، ء)

Table 2 shows that the graphical units consist of more than two types of shapes, such as /al-bā'/, which is made up of a dot and part of a rectangle, and/dād/, which is formed from a dot, half of a circle, and part of a large circle. There is one letter, /'alif/, which consists of a single form that is a straight line. Perhaps for this reason, it makes the first alphabet in order, a transition from the simple to the complex, and it is chosen geometrically as a measure for the proportions of the other letters.

From this graphic disclosure, we can assert that our perception of a particular letter is based on its group of parts, which vary from person to person according to their prior experiences. If we asked a group of people to write the letter /'alif/, which, as we have seen, is merely a vertical straight line, we would see various patterns for this letter in terms of length, size, speed of formation, pressure on the paper, positioning in whiteness, and its relationship to the size of other letters. Table 3 shows examples of the graphological performance of the letter "rā'" as observed from some individual graphics formations.

Table 3: Graphological performance of the letter /rā'/

Graphic unit	Some possible cases for the formation of the letter "rā'"			
rā'				
				
				

This graphic diversity is somewhat similar to verbal performance in linguistic research (Jābir, 1998)

From the above, the process of forming graphical units requires several cognitive processes, the most important of which are presented in Fig. 3.

Each of these stages has its importance depending on the need. The stage of acquisition and visual perception is the final registration of graphical units, and the stage of identification and recall is a reflection of what is already in the mind.

4.3 Trends in the interpretation of identification and perception of forms

There is general agreement among most cognitive psychologists that cognitive psychology is the science of forming and managing various types of information that an individual acquires, as well as the processes related to how this information is acquired, retained in memory, and reused. These operations are collectively referred to as cognitive processes.

There have been several main trends in the interpretation of these psychological processes and phenomena, including one that focuses on the individual and another on the environment (Jābir, 1998), along with what is known as the Gestalt School. In the book "The Significance of Image" "for a systematic approach to visual discourses, Bernard Cocula and Claude Perrotet (1986) provide abstracts and compositions of the most important contents of the theoretical heritage of Gestalt regarding visual perception in general and forms and images in particular (Al Magri, 1991, p. 19). They outline a set of laws according to which a group of elements can be perceived as a form:

Law 1: Law of Smallness: The small form stands out separately from larger depths.

Law 2: Law of Simplicity: The simple form is more prominent than the complex form.

Laws 3 and 4: The Laws of Regularity and Reciprocity: This pertains to the orderly and reciprocal division of the elements of a particular form.

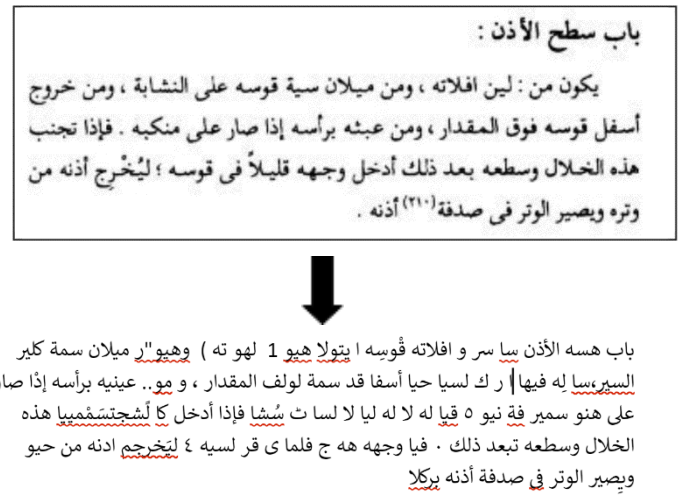
Law 5: Law of Difference: This allows the innovatively shown shape to stand out better. These laws focus on distinguishing shapes from depth. Regarding the elements that make up shapes, the authors promote a set of criteria for recognising certain elements as constitutive elements of a particular shape: namely, proximity, similarity, and sequence criterion.

Talking about the whole and the parts, separation and discrimination, shape and depth, stability and its standards requires talking about the problem of perceiving space (already referred to in the elements of the graphical structure), and Gestalt means all the geometric manifestations of things. It mainly relates to elements: location, direction, magnitude, distance, etc. These concepts seem to have a strong relationship with the graphical structure, and they must be considered when algorithmically designing letters.

4.4 Difficulties in recognising Arabic handwriting

Visual Character Recognition (O.C.R) programs, despite their current effectiveness, face many challenges with respect to Arabic handwriting that all researchers from specialised institutions seek to address. The main difficulties concern the diversity of the shape of letters, size variation, connecting letters, dotting, connecting letters, and diacritics.

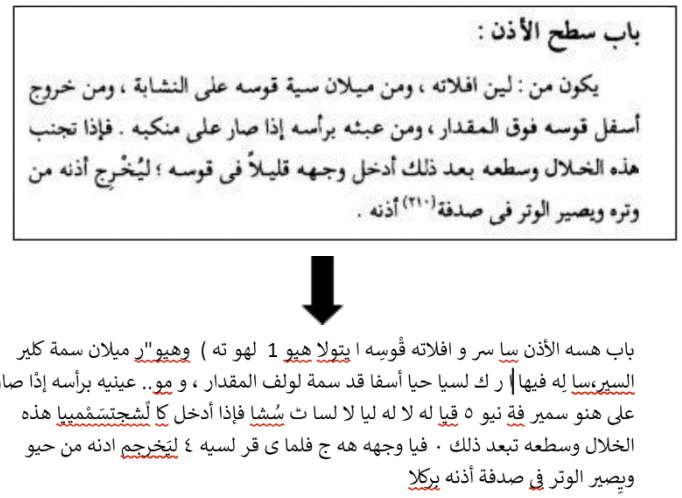
These difficulties pose challenges to the validity of the results during identification, whether at the level of graphic signs (letter, syllable, word) or lines (sentence, paragraph). Figs. 6 and 7 present a typical representation of this.


باب سطح الأذن :

يكون من : لين افلاته ، ومن ميلان سية قوسه على النشابة ، ومن خروج أسفل قوسه فوق المقدار ، ومن عبثه برأسه إذا صار على منكبه . فإذا تجنب هذه الخلال وسطعه بعد ذلك أدخل وجهه قليلاً فى قوسه ؛ ليُخْرِج أذنه من وتره ويصير الوتر فى صدفة[٢١٠] أذنه .

باب هسه الأذن سيا سر و افلاته قُوسِه ا يتولا هيو 1 لهو ته) وهيو"ر ميلان سمة كلير السيرسيا لِه فيها ر ك لسيا حيا أسفا قد سمة لولف المقدار ، و مو.. عينيه برأسه إذا صار على هنو سمير فة نيو ٥ قيا له لا له ليا لا لسا ث سُبشا فإذا أدخل كا لَشجتسَمْميا هذه الخلال وسطعه تبعد ذلك ٠ فيا وجهه هه ج فلما ى قر لسيه ٤ ليَخرجم ادنه من حيو ويصير الوتر فِي صدفة أذنه بركلا

Figure 6: Search result by identifying the word (taṣdīf)


باب سطح الأذن :

يكون من : لين افلاته ، ومن ميلان سية قوسه على النشابة ، ومن خروج أسفل قوسه فوق المقدار ، ومن عبثه برأسه إذا صار على منكبه . فإذا تجنب هذه الخلال وسطعه بعد ذلك أدخل وجهه قليلاً فى قوسه ؛ ليُخْرِج أذنه من وتره ويصير الوتر فى صدفة[٢١٠] أذنه .

باب هسه الأذن سيا سر و افلاته قُوسِه ا يتولا هيو 1 لهو ته) وهيو"ر ميلان سمة كلير السيرسيا لِه فيها ر ك لسيا حيا أسفا قد سمة لولف المقدار ، و مو.. عينيه برأسه إذا صار على هنو سمير فة نيو ٥ قيا له لا له ليا لا لسا ث سُبشا فإذا أدخل كا لَشجتسَمْميا هذه الخلال وسطعه تبعد ذلك ٠ فيا وجهه هه ج فلما ى قر لسيه ٤ ليَخرجم ادنه من حيو ويصير الوتر فِي صدفة أذنه بركلا

Figure 7: Search results by identifying a paragraph

This deficiency has led many institutions and specialists to strive to improve the significant recognition rates, but in the researcher's opinion, they remain insufficient (Nassar, 2010). When we compare what computer programs have achieved in identifying the handwritings in other languages, such as Latin, the main reason for the failure with Arabic handwriting is the clear difference between the Latin handwriting systems and the Arabic as well as similar handwriting systems such as Persian and Urdu.

4.5 Cognitive foundations of automatic recognition of the Arabic handwriting

Arabic handwriting incorporates various linguistic features and serves a crucial communicative function, which can be demonstrated through several linguistic theories.

4.5.1 Learning theory for Arabic handwriting

Learning is a psychological and educational process that occurs through an individual's interaction with their environmental experiences, ultimately leading to an increase in knowledge, tendencies, values, and behavioural skills. Theories in this domain comprise proven logical descriptive rules that focus on understanding and interpreting learning behaviour from a distinct perspective. The theory of learning encompasses the acquisition of various linear forms of Arabic letters, alongside the rules and regulations required for their distinction and identification. These responses arise from stimuli or incentives that enhance attempts to recognise and comprehend these forms, enabling individuals to grasp the meanings of the letters and

the rules governing their formation according to the following aspects:

- Adherence to linguistic and non-linguistic rules while learning Arabic handwriting.
- Access to a range of linguistic information available through practising the forms of Arabic letters.
- Development of abstract hypotheses to draw the lines of polymorphic hamza, allowing for the assimilation and formulation of limitless linear forms resembling them while isolating shapes that do not align with their depiction according to human linguistic competence. This competence refers to the implicit understanding possessed by the user of these rules and the performance that represents the application of this competence in its context, in response to stimuli or incentives. Behavioural theory interprets learning as responses to specific stimuli directed by established rules.

For instance, when executing procedural steps, a child learns Arabic handwriting and utilises cognitive abilities to grasp the instructions and guiding principles for line units. When the child effectively completes the necessary steps in practice, procedural knowledge is executed automatically or unconsciously without the need for concentrated attention. Higher cognitive abilities facilitate skills such as classification, organisation, and comparison of linear units, leveraging memory to gather and analyse information. This leads to a stage of creativity, where imaginative thinking emerges, fueled by acquired hypotheses and predictions based on available information to elucidate phenomena regarding linear units or resolve problems. Subsequently, the child examines and evaluates hypotheses through understanding and application that aligns with a stored image of the presented model, facilitating automatic identification, which aids in forming or generating Arabic letters. The brain captures the data and retains the drawings of Arabic letters, including variations in font size and adjustments such as adding or removing dots. Font size is a common challenge in handwriting development; children often struggle with ensuring letters remain within the appropriate size constraints. Many handwriting issues arise from a lack of readiness to utilise different forms and sizes and coordinate the spacing between letters, which must be meticulously considered for optimal recognition and memorisation of spelling rules to enhance handwriting recognition and production. The didactic techniques in handwriting serve as sensory tools, perceptual in nature, based on linear classifications and groupings according to the following:

4.5.2 Classification of linear units

- {'alif, lām}: The /lām/ differs from the /'alif/ only in the part that comes down from the line.

- {bā', tā', thā'}: /bā'/, /tā'/, and /thā'/ differ only in the number of dots.

- {gīm, hā', xā', 'ayn, ğayn}: /gīm/, /hā'/, /xā'/, /'ayn/, and /ğayn/ do not differ, except in the direction of its head on the line.

- {dāl, zāy, fā', qāf} {rā', zāy, nūn}: /rā'/ and /zāy/ differ from /nūn/ only in the completeness of the /nūn/ arc to form a semi-closed circle above the line.

- {Sīn, Shīn, Sād, dād}: /Sīn/,/Shīn/, /Sād/, and /dād/ differ only in the fact that /Sīn/ and /Shīn/ are serrated from /Sād/ and /dād/ and differ in the number of dots between /shīn/ and /dād/.

- {hā'}:It has an elliptical shape.

- {ṯā', ḏā'}: The /ṯā'/ and /ḏā'/ differ only at the dot above the /ḏā'/.

- {kāf}: Addition of italics above /kaf/.

- {yā'}: It has a twisted shape.

{ } represents the void between the linear letters during their separation.

{ - }: The appendix that connects the linear units to connect them, whether in the middle, the beginning or the end.

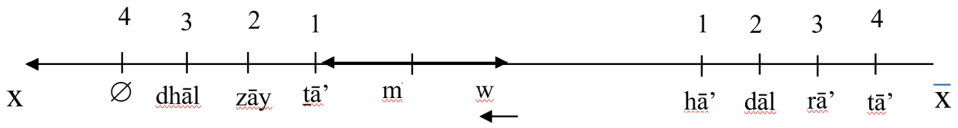
The following combinations can explain these classifications and comparisons of linear letters:

Gr. (L) = {'alif, bā', tā', thā', gīm, hā', xā', dāl, ḏāl, rā', zāy, sīn, shīn, sād, ḍād, ṯā', dā', 'ayn, ğayn, fā', qāf, kāf, lām, mīm, nūn, hā', wāw, yā', hamza, -}.

The Arabic letters /h/group has an important speciality: if we take a line x m x and a landmark.

(m,w) where (w) is a unit ray parallel to (x m x). It is possible to represent the elements (h) in the dots of this line in the sense that graphically similar n dots offset each linear unit x, and each dot e of the line is offset by a linear unit (y). Therefore, a dot

of the line can represent each element of the rest of the group of linear units, and each dot of this line does not need to correspond to an element of that group: for example:



4.5.3 Characteristics of the groups classified among them

Affiliation of linear units in the group

If (bā’) is an element of the group{tā, thā}, and we read /bā’/ belongs to {tā, thā}, we say that (bā) belongs to {tā, thā}, and we write (bā’) ∈ {tā’, ṯā’} and we read /bā’/ belongs to {tā’, ṯā’}; if we want to deny the affiliation of (bā’) to the group {tā’, ṯā’} as it does not have a dot from above the line that is written on it, but from below it, such as (tā’) and (ṯā’), we write (bā’) ∉ {bā’, tā’}, and we read /bā’/ does not belong to the group {tā, thā}.

The empty set { }

It is the designation of a distinctive group, especially the space between the linear units in a state in which they are installed with each other, such as: /bāb/:

The (bā’) sticks to the /’alif/, but the second /bā’/ is not associated with the /’alif/ because the /’alif/ is a linear unit that cannot be connected to anything beyond it

Containing linear units in a group

We note from the group {sīn, shīn, ḍād, ṣād} that there are two graphs {sād, ḍād} that resemble the two forms of the graphs in the group {ẓā’, ṯā’}. They do not differ except in the shell. We can combine them into a group of units and thus say that the group {ṯā’, ẓā’} is contained in the group {sīn, šīn, dād, ṣād} or that the group {sīn, šīn, ḍād, ṣād} is contained in the group {ṯā’, ẓā’} and the symbol used is Ì to indicate this relationship.

Thus, it is written as follows:

{sīn, šīn, ḍād, ṣād} Ì {ṯā’, ẓā’} or {ṯā’, ẓā’} Ì {sīn, šīn, ḍād, ṣād}

We can also deny this inclusion with other groups: for example, we say that group {’alif} is not contained in group {rā’, zāy, nūn}, and we write {’alif} Ë {rā’, zāy, nūn} or rā’, zāy, nūn} Ë {’alif}.

Intersection of linear units in groups

Let the groups be the following: {bā’, tā’, thā’}, {gīm, hā’, xā’}, {’ayn, ğayn},{dāl, ḏāl, fā’, qāf}, {rā’, zay, nūn},{ṯā’, ḏā’, yā’}, containing linear units that bear one or more dots in their drawing: that is, they are characterized by a common characteristic among them, from which we write {bā’, tā’, thā’} Ç {gīm, hā’, xā’}, {’ayn, ğayn}, Ç {dāl, ḏāl}, {fā’, qāf} Ç {rā’, zāy, nūn} Ç {tā’, ẓā’} Ç {yā’} = {bā’, tā’, thā’, gīm, xā’, ğayn, ḏāl, fā’, qā’f, zāy, nūn, ẓā’, yā’}. Using Venndiagrams, this intersection is represented in Fig. 8

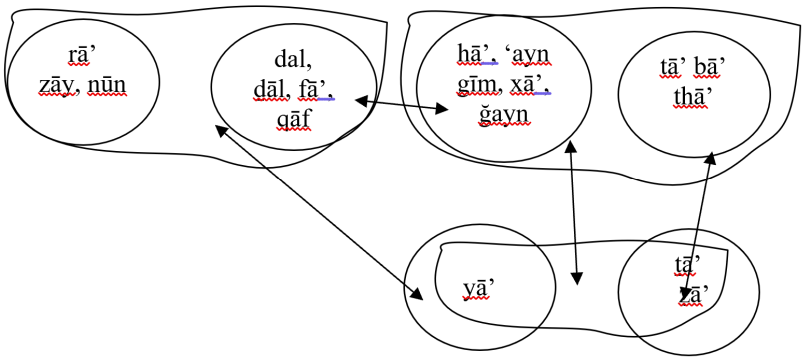


Figure 8: Intersection diagram between linear units

V. THE DOT, ITS CONCEPT AND ITS ROLE IN THE COMPUTERIZATION OF ARABIC HANDWRITING

5.1. Functions of the dot

Despite the limited dimensions of the dot and the simplicity of its formation, it has many functions, which we briefly mention below:

5.1.1 Syntactic function

Abu Al-Aswad used it to denote the syntactic movements. He addressed his writer: "Take the Quran and a dye that contradicts the color of the ink. If I open my lips, drop one above the letter, and if I join it, make the dot next to the letter, and if you break (Kasra) it, make the dot at the bottom of it" (Ibn Al-Anbari, 1971, p. 41). The dot thus became a grammatical unit (morpheme) to avoid the error and the defect and disorder in the synthetic level of the language that the non Arabs produce.

5.1.2 Discriminatory function

This function is credited to Nasr bin Asim and Yahya bin Yaamur, as it became a phonetic unit and a tool for interrogating letters to distinguish some letters from others (similarities and isotopes). Thus, the dot became involved in structuring half of the number of letters in Arabic handwriting: namely, bā', tā', thā', gīm, xā', dāl, zāy, šīn, ḍād, ẓā', ğayn, fā', qāf, kāf, nūn.

5.1.3 Semantic function

The dot is a punctuation mark that is used (like the period) to signify the end of phrases and sentences, as well as the relationships between structures and their branches.

5.1.4 Educational function

The dot plays several pedagogical roles, as "the child learns in his early stages of school to draw geometric lines represented in straight, oblique and broken dots... before he learns to write." (Al Qasim, 2015, p. 23).

5.1.5 Aesthetic function

The dot is one of the graphic elements used by the calligrapher to balance the ratios of whiteness and blackness in the linear painting, and it is primarily utilized in the Diwani Glee line, which aims to fill in the gaps with relatively small dots that match the size of the dots of the letters. In addition, the dot is one of the approved beginnings at the beginning of the formation of some letters, as stipulated by Ibn-Muqla (1994, p. 123) in his letter: "as for the beginning of the dot, it is of nine forms: alif, bā', dāl, rā', sīn, lām, nūn, ain, hā'."

5.1.6 The geometric function

The importance of the dot lies in the fact that some mathematical calligraphers consider it as a measure of all letters and adjust all their geometric descriptions. Therefore, it is the basic unit for measuring the geometric dimensions of letters and all graphemes, including spaces (both white and black) (see Fig. 8). Thus, it is considered a geometric criterion for the computerisation of letters because of its close correlation to the shape of the letter and its ability to form mathematical and logical equations. These equations can accommodate all standard Arabic letters in the first

stage, followed by their applications to handwriting. Handwriting is only a graphical representation of model letters.

5.2 Ibn Muqla's geometric rules for drawing letters

Ibn Muqla had a wide knowledge of geometry, which helped him to develop the calligraphy. The beauty of his fonts was admired in history and literature books. After the Kufic font use in writing the Koran was common, Ibn Muqla introduced the artistic Naskh font, which was praised for its beauty, ease of writing, and clarity. The Kufic font is used only to write the names of the Suras in the Koran. Ibn Muqla, following the example of Ibn Al-Bawwab, completed and perfected the rules of the Naskh font, inventing many of the pens (fonts) on the principles of geometric drawings. He established the font criteria by which a percentage of the interval is set. If it exceeded that ratio, it would be ugly, and if it fell short of that ratio, it would be dull.

Ibn Muqla attributed all letters to the Alif, which he used as a basic measure. Then, he drew a circle around it and placed the rest of the letters in relation to the Alif circle.

5.3 The standard dot for Arabic handwriting

Form—any form—would not exist "were it not for its mother, the dot. The line is the son of the dot, and the line is the father of form. Form is a space open to experimentation and accumulated visual experience, to the extent that we see today in the digital light signals that we transmit electronically" (Abu ʿArab, M., 2023).

Therefore, Ibn Muqla begins by placing a small dot inside the circle to draw the Alif. The standard Alif is a straight line consisting of specific dots placed on top of a peak. The number of dots varies according to the script type – for example, Naskh or Roqa'a – ranging from five to seven, with the height of the circle equaling that of the Alif. The Alif and the circle are reference geometric shapes; Alif is the diameter, and all the letters are built on this diameter. For example, /rā'/ occupies a space equivalent to a quarter of the circle and /Bā'/ is the length of the horizontal diameter of the circle. Furthermore, Ibn Muqla explains that a quarter of the circle consists of six dots. To complete the circle, thirty-two dots must be placed. This simple method establishes the rules of the line, which affords the calligrapher the freedom to innovate and create the forms of the letters, limited only by the proportion of the surfaces. For example, the size of the shape /rā'/ will be constant, and regardless of how often the proportion of a quarter of the circle's circumference is repeated, each letter is a standard form containing dozens of internal sounds, leaving ample opportunity for calligraphers to design and innovate.

Ibn Muqla gave names to some movements within the letters, such as montaseb (stretched), munkab (bended), and mukawwas (arched), which helped him to describe them and the relationships between them. He explained that if another letter is added to some letters, they can generate a third letter, and that is the basis for the formation of the circle in the letters /hā'/, /fā'/, /yā'/, /nūn/, /'ayn/. The semi-circle is manifested in the formation of /sīn/, /sād/, the quarter of the circle in /rā'/, /wāw/, the triangle in /dāl/, /lām/, and the square in /mīm/, and it is measured on all other letters according to the geometric shape that fits the group of letters of the semi-circle, the quarter of the circle, the square of the circle, or the triangle of the circle (Al-Masʿūd, 1981). This can be presented geometrically as follows:

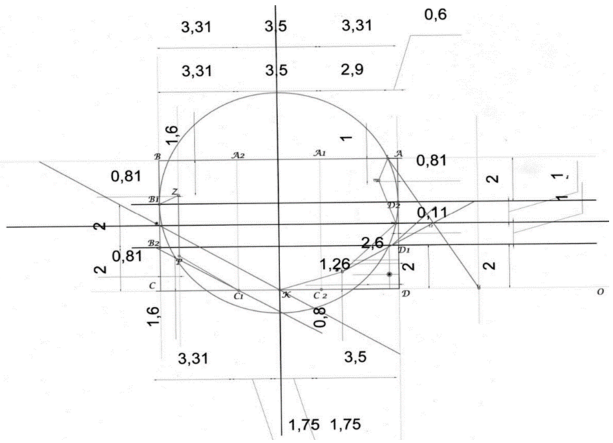


Figure 9: Standard dimensions of the geometry of the letter (rā')

Through Ibn Muqla's thinking on systematizing the forms of letters, several key principles emerge. First, he began with geometric statements in the development of letter scales and the aesthetic proportions of each linear sign (grapheme). Second, he conceived all Arabic letters as units in an integrated and indivisible system. Finally, he emphasized the importance of engineering and mathematical reasoning in examining natural, industrial, and other forms and perceptions. This remains relevant today by integrating heritage concepts and theories to address character computing and automatic processing issues.

In addition, the concept of the dot as a unit of measurement in Ibn Muqla's work is considered similar to the consonants and vowels of Khalil bin Ahmed Al-Farahidi, or as (0 / 1) in modern algorithms. This demonstrates the effectiveness of the mathematical equations derived from the geometry of Arabic handwriting.

VI. CONCLUSION

Computing and automated processing play an active role in addressing the challenges posed by the Arabic handwriting system, which has unique technical and aesthetic characteristics. The efforts made in the field of computerising Arabic handwriting and its automatic processing by individuals and contemporary electronic software companies largely replicate the initiatives undertaken in the computerisation of Latin handwriting. These efforts, though, appear insufficient.

To understand why these efforts fall short, it is necessary to consider the interrelationship between the technical-aesthetic and the geometric-automatic aspects of Arabic letters. These aspects are influenced by linguistic controls derived from the structure and system of the Arabic language itself, as well as the mechanisms of visual and cognitive letters recognition, which are governed by form recognition standards.

Building on this perspective, the study highlighted the importance of leveraging the aesthetic, artistic, and geometric heritage reflected in the approach of Ibn Muqla and those who followed him in the Arabic letters design to address the challenges of recognising Arabic handwriting.

Therefore, any proposed solutions to the challenges of recognising Arabic handwriting must consider all the structural elements of the graphic system, the simplest of which is the dot. This represents a standard, geometric, and cognitive unit. If computer engineers and linguists combine their efforts, they can create mathematical algorithms capable of providing more reliable and valid results for all Arabic handwriting, from typography to handwriting.

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