CONCEPTS IN PHYSICS

A Comparative Cognitive Analysis of Arabic and French Terminologies

This book offers substantial insight into students' conceptualization of scientific terminology. The current book explores the commonalities and distinctions between Arabic and French physics terms, and the impact of the language disparities on students' understanding of physics terms. This book adopts a new approach to the problem of scientific terminology by exploring physics terms' polysemy, prototypical meanings, and conceptual metaphor and metonymy, which motivates the extension of their meanings. The book also investigates how the linguistic discrepancies and other variables affect the learning of physics by Arab students (particularly Moroccan students). *Concepts in Physics: A Comparative Cognitive Analysis of Arabic and French Terminologies*, whether you are a student of science, a science teacher or lecturer, a translator, or a linguist, is the reference you need. The book will help you comprehend the linguistic and cultural differences between western and non-western physics terminologies (in this book, French and Arabic physics terminologies) and the factors influencing the learning of physics concepts, and thus address the multiple challenges in learning scientific terms and concepts.

ITBM
Institut Terjemahan & Buku Malaysia

Hicham Lahlou

Concepts in Physics
A Comparative Cognitive Analysis of Arabic and French Terminologies

ITBM

CONCEPTS IN PHYSICS
A Comparative Cognitive Analysis of Arabic and French Terminologies

Hicham Lahlou

Concepts in Physics: A Comparative Cognitive Analysis of Arabic and French Terminologies

Concepts in Physics: A Comparative Cognitive Analysis of Arabic and French Terminologies

HICHAM LAHLOU

ITBM
Institut Terjemahan & Buku Malaysia
Kuala Lumpur
2021

This book **CONCEPTS IN PHYSICS: A COMPARATIVE COGNITIVE ANALYSIS OF ARABIC AND FRENCH TERMINOLOGIES** is published by Institut Terjemahan & Buku Malaysia.

Published by:
INSTITUT TERJEMAHAN & BUKU MALAYSIA BERHAD
Wisma ITBM, No. 2, Jalan 2/27E
Seksyen 10, Wangsa Maju
53300 Kuala Lumpur
Malaysia
Tel.: +603-4145 1800 Fax: +603-4143 2939
E-mail: publishing@itbm.com.my Website: www.itbm.com.my

First Published in 2021

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Hicham Lahlou
Concepts in Physics: A Comparative Cognative Analysis of Arabic and French Terminologies / HICHAM LAHLOU.
ISBN 978-967-460-895-8
1. Physics--Terminology
2. Arabic language--Terms and phrases.
3. French language--Terms and phrases.
I. Title.
530.014

Printed in Malaysia by:
GLOBAL SMART PRINTINGS SDN. BHD.
SA-SG 20, Jalan UP 1/1A
Springville, Taman Ukay Perdana
Ukay Perdana, Ampang
68000 Selangor.

CONTENTS

PREFACE

The present book addresses the problem of scientific terminology in Arab countries in general and Morocco in particular. This issue is of great concern in the fields of science education, language policy and translation. Previous studies on the conceptualisation of scientific terminology centred on the differences in non-western settings between western and non-western languages and cultures, or on the differences in western contexts between ordinary speech and scientific language. In contrast, this book is the first attempt to bridge the divide between studies addressing the differences between ordinary speech and scientific language, and studies addressing the differences between western and non-western languages and cultures. In other words, the book covers the issue in its both manifestations – the difference between non-western scientific terminology and western scientific terminology on the one hand and everyday speech and scientific language on the other. The book draws upon a multidisciplinary background in cognitive linguistics, particularly theories of metaphor and metonymy, and corpus linguistics.

Throughout the author's primary and secondary school experience, his schoolmates and he faced various issues in comprehending scientific concepts though the medium of instruction was French. The reasons for such problems were complex, from the packed curriculum to the lack of practical work in science classes. Changing the medium of education into

Arabic at the primary and secondary school levels in the 1980s emphasised the low progress in students' learning of science.

To date, investigations into the issue of scientific terminology in the Arab world in general and Morocco in particular are still ongoing despite the considerable literature published on it. Previous research centred on some of the problem's external factors: language policy, system and attitude. Despite the prominence of the sociopolitical aspects, it is essential to investigate the other external factors like pedagogical factors and internal factors such as the conceptual structure of science' language to gain a revealing insight into students' *misconceptualisation* of scientific concepts.

The author would particularly like to express his deep gratitude to Professor Hajar Rahim for her invaluable suggestions and criticism of previous versions of this work. I would also like to express my thanks to the School of Humanities staff, Universiti Sains Malaysia (USM), especially Professor Narimah Samat.

I extend my heartfelt gratitude to Abdelmalek Essaadi University staff, especially Professor Ahmed El Moussaoui, Deputy Vice-Chancellor (Research and Cooperation) and Professor Noura Aknin.

I want to thank all the 1st year students from Ecole Nationale des Sciences Appliquées (National School of Applied Sciences) and Faculté des Sciences (Faculty of Sciences), Abdelmalek Essaadi University. They contributed to this project by participating in the pilot and actual focus group interviews, and sharing their perceptions and experiences of physics terminologies and their impact on physics concepts.

Hicham Lahlou

CHAPTER 1

INTRODUCTION

Language is a constant concern in science education worldwide. Current research on learners' misconceptions of scientific terminology documented that language is a pressing concern in science education universally. Previous studies indicated that western learners experience difficulties in understanding scientific concepts because of the difference between everyday speech and scientific language (e.g., Carey, 2000; Duit & Kesidou, 1988; Jones, 1983; Strömdahl, 2007; Trowbridge & McDermott, 1980, 1981). Learners in non-western countries, in contrast, find even more practical difficulties as their native language and scientific language are entirely different. A non-western scientific terminology like Arabic terminology of science may not convey the same meanings as the original language of western science (e.g., English or French scientific terminology) and may therefore carry different concepts.

Modern science is the outcome of western scientists' contributions and is therefore related to western heritage (Kawasaki, 1996). Given this, linguists and educationists have conducted considerable research on students' misconceptions of scientific concepts in non-western countries and the impact of linguistic factors on understanding them. Ennaji (2005) asserted that one of the main problems in teaching science in non-western countries is the language used in science classes. Using a non-western language may not convey the same meanings and may, therefore, carry

different concepts. The works of Sapir (2004) and Whorf (2012) shed light on the dissimilarity of languages. However, such research was disregarded during the subsequent decades as linguistic research generally focused on language universals and the extent of similarities among languages, influenced by Chomsky's theory proponents.

In non-western nations that use the local language to teach science, science-based materials written in western languages like English and French were translated into their native language. This may seem to be the best way to achieve the aim of science education in their context. However, translating scientific terms from western languages to other languages can be problematic. Many senses of scientific terms may change in the process of translation. Importantly, people perceive many real and physical phenomena differently across languages (e.g., Aikenhead, 2001; Kawasaki, 2002, 2007; Aikenhead & Ogawa, 2007).

Several studies suggest that translation from western languages to other languages is not entirely successful as many senses of words change in translation. With the rapid development in science and technology, translating science from western languages to other languages has become more challenging, which has negatively affected teaching science in non-western countries. This can be best exemplified in Kawasaki's (1996) work, who discovered that the English term *observation* was wrongly translated to *kansatsu* in Japanese. According to the western perspective, the observer must be separated from the observed. However, from the Japanese perspective, the term *kansatsu* does not demand the observer's separation from the subject of observation. Therefore, learners understand the scientific concepts from the Japanese view of science, not the western perspective (e.g., Kawasaki, 2002, 2007; Michie, 2005).

The language used in teaching science and technology in non-western nations differs from one nation to another. While many non-western countries like Nigeria and Senegal use western languages like English and French in teaching science and technology, some countries, such as Japan and Syria, use their mother tongue in teaching science and technology. A third situation is where both western and non-western languages are used in science education. Typical examples of these countries are Morocco

and Tunisia. In these nations, Arabic (first language) is the default medium of instruction at the primary and secondary levels, while French (second language) is commonly used at the tertiary level. This makes science teaching and learning more complicated because of the sharp transition from Arabic, the medium of instruction at high school, to the second language, the medium of teaching at university. Most students at this stage possess only a basic command of the second language.

In the Moroccan context, Arabic is the medium of instruction at the primary and secondary levels, while French is the medium of education at the tertiary level. The transition from Arabic to French at the university level makes the issues that students face in learning scientific terms and concepts more complicated. Moroccans learn their dialect and then start learning Arabic in primary school. They then study science in Arabic (with some subsidiary French materials) before studying science in French at university. The linguistic difficulties in understanding science lie in the gap between everyday speech (Moroccan dialect) and the language of science, and between Arabic and French. All these challenges culminate in the first year at university when the medium of instruction changes, adding to the struggle with the transition process from school to university. The change of the teaching medium to the second language and learners' basic command of the second language, especially for first-year learners, may impede learning science at the tertiary level.

A growing body of literature investigated the medium of instruction in the Arab countries, including Morocco. However, for the most part, such research was sociopolitical as the focus was on language policy, system and attitude. Despite the recurring problems about the medium of instruction, there has never been any research to explore the extent of the differences between Arabic and western science terminologies and concepts. There has also been no attempt to determine whether these differences pose a barrier to learners' understanding of science. This constitutes the motivation behind the present comparative study on Arabic and French terms used in physics. The findings of the current research and those carried out in other contexts help identify the areas of differences crucial for addressing concerns in science education policies and the

medium of instruction in non-western countries. They also contribute new knowledge towards language debate in terms of language universals and specificities.

This is the first cognitive linguistic study to unravel the conceptualisation of Arabic terms used in physics, especially those also used in everyday language. It is believed that the present book has important implications for science curriculum design, education and language policy in the Arab countries in particular and other non-western contexts in general. It also contributes to cognitive linguistics with new knowledge on the universal and culture-specific use of conceptual metaphor and metonymy in Arabic and French.

In the present book, 16 concepts are selected from physics primary and secondary school textbooks to approach their linguistic denotations in their real context. There is evidence that physics is more associated with humans' construal of the world than any other science area as its main objective is to understand how the universe works. It helps humans understand the environment in which they live. Physics involves knowledge of matter and energy, their forms, properties, and interactions (Deeson, 2007). Physics also depends widely on semantics and metaphorical extensions in understanding physical phenomena. As humans generally comprehend scientific terms via physics concepts, it is the most essential and comprehensive science field, which impacts science development (Feynman, Leighton & Sands, 2013).

As mentioned above, the number of scientific concepts selected for the current study is 16. Limiting the number of concepts is necessary to make the data set under study manageable and sufficient for the cognitive analysis. Past research on physics terminology focused on only one or two scientific concepts across languages. The focus on 16 physics concepts in the present study is a novel attempt to provide an adequate and inclusive data set and considerable insight into what constitutes an Arab student's prior knowledge of physics terminology. It represents various physics concepts, a broad background for cognitive categorisation, and exhaustive data on the meanings, prototypes and cognitive mechanisms.

Thus, as shown in Table 1.1, the Arabic and French terms denoting the physics concepts under study[1] are analysed to identify the similarities and differences between their senses, prototypes and semantic extensions.

Table 1.1 Physics Concepts and their Arabic and French Linguistic Denotations.

Concepts Under Study	Arabic and French Linguistic Denotations	Concepts Under Study	Arabic and French Linguistic
HEAT	حَرَارَة (*ḥarāra*) **chaleur**	**MASS**	كُتْلَة (*kutla*) **masse**
TEMPERATURE	دَرَجَةُ الحَرَارَة (*darajatu al-ḥarāra*) **température**	**INERTIA**	قُصُور ذَاتِي (*qusūr ḏāti*) **l'inertie**
ENERGY	طَاقَة (*ṭāqa*) **énergie**	**MOTION**	حرَكَة (*ḥaraka*) **mouvement**
FORCE	قُوَّة (*quwwa*) **force**	**SPEED**	سُرعَة (*surʿa*) **vitesse**
POWER	قُدْرَة (*qudra*) **puissance**	**ACCELERATION**	تَسَارُع (*tasāruʿ*) **accélération**
ELECTRICITY	كَهْرَبَاء (*kahrabāʾ*) **électricité**	**WAVE**	مَوْجَة (*mawja*) **onde**
PRESSURE	ضَغْط (*ḍaġṭ*) **pression**	**LIGHT**	ضَوْء (*ḍawʾ*) **lumière**
WEIGHT	وَزْن (*wazn*) **poids**	**SOUND**	صَوْت (*ṣawt*) **son**

1. In the current book, lexical items like words and terms are ***italicized***, as in *heat*, meanings are placed in inverted commas, e.g., حَرَارَة (***ḥarāra***) (heat) 'being or feeling hot or warm', transliterated and translated words are placed in brackets, as in حَرَارَة (***ḥarāra***) (heat). Concepts are denoted using SMALL CAPS, e.g., HEAT.

The book sets out to find the commonalities and differences between Arabic and French physics terminologies. To this end, the author analyses 16 Arabic terms and their French renderings in terms of polysemy, prototypes, conceptual metaphor and conceptual metonymy. The analysis data consist of physics terms meanings in Arabic and French, derived from dictionaries and two comparable corpora, the *ArabiCorpus* and the *Concordancier-Corpus Français*. Furthermore, the author uses these corpora to generate data on the most frequent collocates of the terms under investigation and unravel their prototypes in each language. The author also employs focus group interviews to investigate how linguistic differences and other factors affect Arab students' learning of physics (Moroccan students, in the present book).

The book consists of eight chapters. Chapter 1 introduces readers to the problem of students' conceptualisation of scientific terminology. Chapter 2 to Chapter 5 familiarises readers with the cognitive view of language, discussing the relationship between language and thought, and students' *misconceptualisation* of scientific terms. It also discusses categorisation and cognitive factors motivating meaning extension. Chapter 6 compares and contrasts Arabic and French words used in physics in polysemy, prototypes and semantic extension motivation. Chapter 7 explores Moroccan students' conceptualisation of the physics terms under investigation and their views on the factors that influence their understanding of the words. Finally, Chapter 8 concludes the book.

As for the semantic extensions, one of the meanings of the noun *température* is metaphorically used to talk about people's feelings and attitudes.

9. ... ***prenaient la température de l'opinion publique internationale.***
... gauging the feelings of world public.

This semantic extension can be explained in terms of MEASURE OF MIND IS MEASURE OF BODY metaphor. In this image, BODY (the source domain) is mapped onto MIND (the target domain); the knowledge about taking the temperature of mind is understood in terms of taking the temperature of body.

Summing up, Arabic دَرَجَةُ الحَرَارَة and French *température* exhibit both similarities and differences. They carry the meanings of 'the degree of hotness or coldness' and 'fever'; however, the meanings 'relative state of emotional warmth or temperament' and 'feelings, frame of mind' can only be used within the domain of *température*. Both of them are associated with the same prototype, MEASURE. No metaphorical extension of the compound دَرَجَةُ الحَرَارَة was encountered in the corpus. French *température*, in contrast, underwent some semantic extensions by the motivation of conceptual metaphor, namely SEXUAL DRIVE IS HEAT metaphor and MEASURE OF MIND IS MEASURE OF BODY metaphor. It should be noted here that, in contrast to French *chaleur* and *température*, both lexical units denoting the concept of HEAT and TEMPERATURE in Arabic involve the word حَرَارَة, namely حَرَارَة and دَرَجَةُ الحَرَارَة.

ENERGY – طَّاقَة (*ṭāqa*), *énergie*

The scientific concept of ENERGY is linguistically denoted by the term طَّاقَة (ṭāqa) in Arabic and the term *énergie* in French. The term طَّاقَة may convey the meanings 'ability or strength to do work', 'window', 'power/ usable power' and 'capacity of production'. The term *énergie*, in contrast, denotes 'the physical or mental effort used to do something', 'force with which a sound is articulated' and 'power/a source of power'. Considering the multiple meanings of both terms, it is remarkable that some comparable

meanings, namely 'ability, strength or capacity for doing work' and 'power/a source of power'. However, some meanings apply to the word طَاقَة only, i.e., 'window' and 'capacity of production'. In the same vein, only the term *énergie* carries the meaning of 'force with which a sound is articulated'.

The top five collocates of طَاقَة are ذَرِّيَّة (*ḏarriyya*) (nuclear), كَهْرَبَائِيَة (*kahrabā'iya*) (electrical), نَوَوِيَة (*nawawiya*) (atomic), إِنْتَاجِيَة (*intājiya*) (productive) and شَمْسِيَة (*shamsiya*) **(solar). The top five collocates of** *énergie* are ***atomique*** (atomic), *force* (force, strength), *nucléaire* (nuclear), *conservation* (conservation) and *courage* (courage). The most prototypical collocates of طَاقَة and *énergie* are thus *nuclear* and *atomic*, respectively. Although there are differences between *atomic* and *nuclear*, especially **in physics, these words overlap when they function as energy modifiers.** It is reasonable to conclude that both terms have the same prototypical association, namely *nuclear*.

The meaning of طَاقَة is extended to 'capacity (of production)', that is, the maximum production possible.

10. وتبلغ الطاقة الانتاجية للمصنع 500 ألف طن متري سنوياً
Wa tabluġu ṭ-ṭāqatu l-'intājiyatu li-l-maṣnaʿi 500 'alfa ṭannin mitri sanawiyyan.
The production capacity of the factory is 500 thousand metric tons per year.

In this example, POWER (ability to produce) is mapped onto QUANTITY (of production) (i.e., measure or scale). Thus, this extension is motivated by PRODUCTIVE FORCE FOR FORCE SCALE metonymy.

The meaning of *énergie* is extended to 'the physical and mental effort used to do something, dynamism, drive'.

11. *Il se sentait plein d'énergie.*
He felt full of energy.

The extension here is from physical to physical and mental, and from ability to activity. ENERGY (i.e., power or forcefulness) is mapped onto DYNAMISM; therefore, this extension is motivated by ACTIVITY IS POWER.

The semantic projection of *énergie* to 'force with which a sound is articulated' can be understood in terms of THE WHOLE FOR PART metonymy as *énergie* **stands for the force or intensity of the air flow in the** vocal tract while articulating a sound, as shown in the following example.

12. ... *la sonorité des diphtongues et l'énergie des labiales, en sont **influencées**.*
... the sound of diphthongs and energy (articulatory force) of labials **are influenced.**

In sum, the lexical units طَاقَة and *énergie* consist of some similar meanings, namely 'ability, strength or capacity for doing work' and 'power/a source of power'. Nonetheless, the meanings of 'window' and 'capacity of production' apply to the word طَاقَة only. Similarly, the meaning of 'force with which a sound is articulated' applies to *énergie* only. It is worthy of note that the senses of طَاقَة **(ṭāqa) as 'a window' and 'bouquet' were** used in two concordance lines in 44,232 occurrences of طَاقَة **(ṭāqa). The** prototype of both طَاقَة and *énergie* is NUCLEAR. Thus, they have similar prototypical meanings though they differ in terms of peripheral meanings, most of which are scarcely employed in Modern Arabic. The semantic extensions of Arabic طَاقَة are not motivated by conceptual metaphor based on the corpus data. Some of the semantic projections of *énergie*, on the other hand, are motivated by ACTIVITY IS POWER conceptual metaphor (*see* Lahlou, 2020).

FORCE – قُوَّة (*quwwa*), *force*

In Arabic, the term used to denote the scientific concept FORCE **is** قُوَّة (*quwwa*) while in French the same English form is used, e.g., force. This similarity is since English *force* originates from Old French (Soanes & Hawker, 2008). Most of the meanings of قُوَّة and *force* show some kind of similarity, notably 'physical and mental strength', 'energy', 'violence', 'power and authority' and 'military or police'. However, only Arabic قُوَّة can be used with the meanings of 'bunch' and 'athletics'. In the same vein, unlike Arabic قُوَّة, French *force* can be used with the meaning of 'intensity'.

CHAPTER 7

CONCEPTUALISATION OF THE PHYSICS TERMS

Several non-western countries like Morocco employ the local language in teaching science at the school level and the western language at the university level. This adds to the diverse challenges of the transition from school to university. A learner's conceptual background is formed in their local language, different from scientific knowledge. A learner may first study in their native language and then gradually learn in a foreign language like English. The final stage is to study science in English. This makes learners' science concepts to be kept within their old concepts, causing confusion between the learners' culture and "science culture" (e.g., Logan, 1981; Lahlou & Hajar, 2020).

In Morocco's context, all these challenges come to their climax when French substitutes Arabic at the tertiary level, raising the burden of the transition from school to university and posing pressing problems for learners' science learning and science education quality. Like several other newly independent nations, Morocco adopted bilingualism in science education. While Arabic is used at the school level, French is employed at the tertiary level, especially in science. Even though this language policy possesses definite advantages, changing the medium of teaching at the tertiary level aggravates the problems confronting learners' learning of science. Adding to these challenges, most students at this stage have an inadequate mastery of the second language given their limited exposure to

that language in secondary school science classes and outside of school. Besides, as discussed in Chapter 2, translation from and to a different language is not precisely successful as many meanings may change in the process of translation (Cobern, 1996b; Aikenhead & Ogawa, 2007; Lahlou & Hajar, 2016).

Changing the medium of instruction at the tertiary level may also negatively impact on science education quality. For a quality model in higher education to succeed, it needs to typify the stakeholders' shared perspectives (Srikanthan & Dalrymple, 2003). It is crucial to consider the diverse positions of stakeholders, i.e., funding bodies and community at large, learners, employers of graduates, and academic and administrative staff, on quality in higher education (Srikanthan & Dalrymple, 2003). Each stakeholder's view must be considered while assessing quality because quality is 'stakeholder-relative', to use Harvey and Green's (1993) expression. Lecturers and students, for example, may emphasise the process of education while employers may emphasise the results of higher education (Harvey & Green, 1993). Learners' perspectives of science education are critical, given that they constitute a significant consumer group of educational services (Hill, 1995; Ulewicz, 2017). Students' satisfaction is a crucial factor that contributes to the success of the higher education industry.

Before examining Moroccan students' conceptualisation of physics terms, it is necessary to discuss the status of language and medium of instruction in Morocco. This is to have a better understanding of Morocco's current linguistic scenery.

THE LINGUISTIC SCENERY IN MOROCCO

The Kingdom of Morocco is situated in the north-western corner of Africa, between latitudes 21° and 36°N. The coast of Morocco has a size of about 3446km: The Mediterranean Sea on the north (512km from Saidia in the east to Cap Spartel in the west) and the Atlantic Ocean on the west (2934km from Cap Spartel in the north to Lagwira in the south). Morocco borders the Republic of Algeria to the east and the Republic of Mauritania

to the south. Morocco has an area of 710.850km² (Ministry of Agriculture and Rural Development, cited in Hammouzaki, 2013). The population of the Kingdom has reached 33,762,036 according to the 2014 census (Data.gov.ma).

Morocco is linguistically and culturally diverse. There are mainly two races: Arab and Berber. Each of these two groups uses different varieties of their language. Arabic is divided into Standard Arabic (i.e., the modern version of Classical Arabic) and Moroccan Arabic (or Darija). This, in turn, has different sub-varieties, namely the dialect of Tangiers, Tétouan and Larache in the north, the dialect of Fes and the dialect of Rabat and Casablanca in central Morocco, the dialect of Marrakesh and Agadir in the south, and the dialect of Hassaniya in the Moroccan Sahara (Ennaji, 2005).

Moroccan Arabic is characterised by some borrowed words from the languages of the country's colonisers, mainly French and Spanish. The French language influences the dialect used in the middle of Morocco. In contrast, the Spanish language affects the ones used in the north of Morocco (e.g., Tetouan and Tangiers) and the Western Sahara area in the south of Morocco. In the same vein, Berber has three major varieties:

1. Tarifit in the Rif Mountains (northern Morocco).
2. Tamazight in the High Atlas Mountains (central Morocco).
3. Tashelhit in southern Morocco (Ennaji, 2005; Redouane, 1998).

Having explained the diverse languages and dialects used in Morocco briefly, it is necessary to consider the main functions of the various language varieties.

Ennaji (2005) provides an interesting classification of the functions of Morocco's main languages and dialects. He asserted that Moroccan Arabic and Berber are used in the realms of home and street. Standard Arabic is applied in the domain of education, public administration and the media. French is used along with Standard Arabic in many areas and takes over the private sector, science and technology (Ennaji, 2005).

The dominance of French in several domains is the outcome of the French colonisation. The Kingdom of Morocco was colonised by two

European countries, namely France and Spain. The French colonial power colonised central Morocco while the Spanish colonial power colonised Morocco's north and south. During the French occupation, the French colonisers strived to advance French language and culture to disconnect Moroccans from their native languages and cultures (Ennaji, 2009).

After independence, Morocco, like several other newly independent nations, opted for a language policy that concentrated on an ideological aim of a linguistically united country. So Standard Arabic was chosen as the official language of the state. Despite this, except for religion and language classes, French remained the only language of instruction until the late 1970s to early 1980s when Arabisation of the curriculum started at both primary and secondary school (Freeman, 2010). Standard Arabic overlaps with French at these levels, especially in physics, natural sciences and chemistry. In contrast, French still covers the field of science in higher education. Overall, French is still used in many domains like business and science, so it is essentially the second language of Moroccans (Ennaji, 2005; Freeman, 2010).

More recently, English has begun to receive attention as students start to learn it in Grade 7 instead of Grade 10. Nonetheless, it is still considered a foreign language like Spanish. French is the primary medium of instruction and plays a vital role in Morocco's socio-economic domain for various reasons. First, it is feared that Morocco would be linguistically isolated and socio-economically disadvantaged if Arabic takes over (Ennaji, 1988). Second, the realisation of Arabisation has been hindered by the constant reliance on French, which is regarded as a developed language of broader communication and easy access to the modern world of science and technology (Hammoud, 1982, cited in Redouane, 1998). Third, language planning and policy have generally been motivated by political interests, and very little attention has been given to educational needs. An insufficient effort has been invested in consulting educational and sociological expertise or in surveying the multitude about Arabisation (Redouane, 1998). Overall, the difficulty in achieving Arabisation has also been the outcome of inconsistencies in language policy, inadequacy in planning and absence of coordination among the offices and public administrations (Bentahila, 1983; Ennaji, 1988; Redouane, 1998).

REFERENCES

Abū l-ʿAzm, A., 2001. *Al-Muʿjam al-Ġanī.* Ṣaḫr dictionary site. Retrieved from http://shamela.ws/rep.php/book/2236.

Aikenhead, G., 2001. Integrating Western and Aboriginal Sciences: Cross-Cultural Science Teaching. *Research in Science Education, 31*(3), 337–355. doi:10.1023/a:1013151709605.

Aikenhead, G. and Ogawa, M., 2007. Indigenous Knowledge and Science Revisited. *Cultural Studies of Science Education, 2*(3), 539–620.

Aitchison, J., 2012. ***Words in the Mind: An Introduction to the Mental Lexicon*** (4th ed.). John Wiley & Sons.

Bentahila, A., 1983. *Language Attitudes Among Arabic-French Bilinguals in Morocco.* Clevedon: Multilingual Matters.

Berlin, B., Breedlove, D.E. and Raven, P.H., 2013. ***Principles of Tzeltal Plant Classification. An Introduction to the Botanical Ethnography of a Mayan-Speaking People of Highland Chiapas.*** New York and London: Academic Press. (Original work published 1974)

Bloor, M. and Wood, F., 2006. ***Keywords in Qualitative Methods.*** London: SAGE Publications.

Bowker, L. and Pearson, J., 2002. ***Working with Specialized Language: A Practical Guide to Using Corpora.*** London: Routledge.

Brislin, R.W., 1970. Back-Translation for Cross-Culture Research. *Journal of Cross-Cultural Psychology*, 1, 185–216.

Brotherson, M.J., 1994. Interactive Focus Group Interviewing: A Qualitative Research Method in Early Intervention. ***Topics in Early Childhood Special Education,*** *14*(1), 101–118. doi:10.1177/027112149401400110.

Carey, S., 2000. Science Education as Conceptual Change. *Journal of Applied Developmental Psychology, 21*(1), 13–19.

Cienki, A., 2007. Frames, Idealized Cognitive Models, and Domains. In D. Geeraerts & H. Cuyckens (Eds.), ***The Oxford Handbook of Cognitive Linguistics.*** New York: Oxford University Press.

Cobern, W.W., 1996a. Worldview Theory and Conceptual Change in Science Education. *Science Education, 80*(5), 579–610.

Cobern, W.W., 1996b. Constructivism and Non-Western Science Education Research. *International Journal of Science Education, 18*(3), 295–310.

Cohen, L., Manion, L. and Morrison, K., 2013. *Research Methods in Education* (7th ed.). London and New York: Routledge.

Crabtree, B. and Miller, W.L., 1999. ***Doing Qualitative Research.*** London: Sage Publications.

Creswell, J.W., 2017. ***Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*** (5th ed.). SAGE Publications.

Croft, W. and Cruse, D.A., 2004. *Cognitive Linguistics.* New York: Cambridge University Press.

Dawson, C., 2002. ***Practical Research Methods: A User-Friendly Guide to Mastering Research Techniques and Projects.*** Oxford: How To Books Ltd.

Deeson, E., 2007. *Collins Internet-Linked Dictionary of Physics.* London: HarperCollins Publishers Ltd.

Duit, E. and Kesidou, S., 1988. Students' Understanding of Basic Ideas of the Second Law of Thermodynamics. *Research in Science Education,* 18, 186–195.

Ennaji, M., 1988. Language Planning in Morocco and Changes in Arabic. *International Journal of the Sociology of Language, 1988*(74), 9–39.

Ennaji, M., 2005. *Multilingualism, Cultural Identity, and Education in Morocco.* New York: Springer.

Ennaji, M., 2009. Multiculturalism, Citizenship, and Education in Morocco. *Mediterranean Journal of Educational Studies, 14*(1), 5–26.

Evans, V. and Green, M., 2006. ***Cognitive Linguistics: An Introduction.*** Edinburgh: Edinburgh University Press Ltd.

Evans, V., 2011. Language and Cognition: The View from Cognitive Linguistics. In V. Cook & B. Bassetti (Eds.), *Language and Bilingual Cognitio*n (pp. 69–107). New York: Taylor and Francis.

Fauconnier, G., 1985. *Mental Spaces*. Cambridge, Mass.: MIT Press.

Feynman, R.P., Leighton, R.B. and Sands, M., 2013. ***The Feynman Lectures on Physics, Desktop Edition Volume I.*** United States: Basic Books.

Fillmore, C.J., 1975. An Alternative to Checklist Theories of Meaning. *In Annual Meeting of the Berkeley Linguistics Society,* 1, 123–131.

Fillmore, C.J., 1982. Frame Semantics. In Linguistic Society of Korea (Ed.), *Linguistics in the Morning Calm* (pp. 111–137). Seoul: Hanshin.

Fillmore, C.J. and Atkins, B.T., 1992. Toward a Frame-Based Lexicon: The Case of RISK. In A. Lehrer, E.F. Kittay, & R. Lehrer (Eds.), *Frames Fields and Contrasts: New Essays in Semantic and Lexical Organization*. Routledge: Taylor and Francis.

Freeman, K.T., 2010. Morocco: A Guide to its Educational System and Advice for the Admission and Placement of Students Educated in Morocco. *International Consultants of Delaware.*

Freitas, H., Oliveira, M., Jenkins, M. and Popjoy, O., 1998. The Focus Group, a Qualitative Research Method. *ISRC, Merrick School of Business, University of Baltimore* (MD, EUA), 1, 1–22.

Geeraerts, D., 2006. Where Does Prototypicality Come From? In D. Geeraerts, R. Dirven, J. R. Taylor, & R.W. Langacker, (Eds.), *Words and Other Wonders: Papers on Lexical and Semantic Topics* (pp. 27–47). Berlin: Mouton de Gruyter.

Geeraerts, D. and Cuyckens, H. (Eds.), 2007. *The Oxford Handbook of Cognitive Linguistics.* Oxford University Press.

Geeraerts, D., 2013. Diachronic Prototype Semantics. A Digest. In A. Blank & P. Koch (Eds.), *Historical Semantics and Cognition.* Berlin: Mouton de Gruyter. (Original work published 1999)

Grady, J. Oakley, T. and Coulson, S., 1999. Blending and Metaphor. In R.W. Gibbs & G. Steen (Eds.), *Metaphor in Cognitive Linguistics* (pp. 101–124). Amsterdam: John Benjamins.

Haiman, J., 1980. Dictionaries and Encyclopedias. *Lingua*, 50, 329–357.

Hammouzaki, Y., 2013. Desertification and Its Control in Morocco. In G.A. Heshmati & V.R. Squires (Eds.), *Combating Desertification in Asia, Africa and the Middle East* (pp. 91–111). Dordrecht, Netherlands: Springer.

Harvey, L. and Green, D., 1993. Defining Quality. *Assessment and Evaluation in Higher Education,* 18(1), 9–34.

Hewitt, P.G., Suchocki, J.A. and Hewitt, L.A., 2014. Conceptual Physical Science. Obeikan Publishing.

Hill, F.M., 1995. Managing Service Quality in Higher Education: The role of the Student as Primary Consumer. *Quality Assurance in Education,* 3(3), 10–21.

Ho-Abdullah, I. and Awal, N.M., 2005. *Conceptualisation of Emotions in Malay: "Hati" (the Liver) as the Source of Emotions*. Paper presented at the 9th International Cognitive Linguistics Conference, Yonsei University, Korea.

Ho-Abdullah, I. and Hashim, R.S., 2009. A Cognitive Semantics Analysis of Alam (Nature) in Malay. *European Journal of Social Sciences*, 8(1), 140–151.

Ibarretxe-Antuñano, I., 2004. What is Cognitive Linguistics? A New Framework for the Study of Basque. *Cahiers de l'Association for French Language Studies,* 10, 2.

Johnson, M., 2008. Philosophy's Debt to Metaphor. In J. Raymond W. Gibbs (Ed.), *The Cambridge Handbook of Metaphor and Thought* (pp. 39–52). Cambridge: Cambridge University Press.

Johnson, M., 2013. ***The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Cognition.*** Chicago: The University of Chicago Press.

Jones, A.T., 1983. Investigation of Students' Understanding of Speed, Velocity and Acceleration. *Research in Science Education, 13*(1), 95–104.

Kaptan, K. and Timurlenk, O., 2012. Challenges for Science Education. *Procedia – Social and Behavioural Sciences,* 51, 763–771.

Kawasaki, K., 1996. The Concepts of Science in Japanese and Western Education. *Science and Education, 5*(1), 1–20. doi:10.1007/bf00426437.

Kawasaki, K., 1999. A Deductive Description of Cultural Diversity of "Observation" in Science Education. *Journal of Science Education in Japan, 23*(4), 19–51.

Kawasaki, K., 2002. A Cross-Cultural Comparison of English and Japanese **Linguistic Assumptions Influencing Pupils' Learning of Science.** *Canadian and International Education, 31*(1), 19–51.

Kawasaki, K., 2007. Towards Worldview Education Beyond Language-Culture Incommensurability. *International Journal of Science and Mathematics Education, 5*(1), 29–48. doi:10.1007/s10763-005-9023-6.

Kennedy, G., 2014. *An Introduction to Corpus Linguistics.* London: Longman. (Original work published 1998)

Kövecses, Z., 2010. ***Metaphor: A Practical Introduction.*** Oxford University Press.

Kövecses, Z., 2018. Metaphor in Media Language and Cognition: A Perspective From Conceptual Metaphor Theory. *Lege Artis, 3*(1), 124–141.

Krueger, R.A., 2014. ***Focus Groups: A Practical Guide for Applied Research*** (5th ed.). US: Sage. (Original work published 1994)

Lahlou, H. and Rahim, H.A., 2016. Culture and Conceptualisation of Scientific Terms: An Analysis of the Concepts "Weight" and "Mass" in Arabic and French. ***KEMANUSIAAN The Asian Journal of Humanities, 23***(2), 19–37. doi: https://doi.org/10.21315/kajh2016.23.s2.2.

Lahlou, H., 2020. A Corpus-Based Cognitive Linguistic Analysis of Pre-Existing **Knowledge of Scientific Terminology: The Case of English Energy and** Arabic طَّاقَة **(ṭāqa).** ***Arab World English Journal for Translation and Literary Studies,*** *4*(1), 3–13. doi: http://dx.doi.org/10.24093/awejtls/vol4no1.1.

Lahlou, H. and Rahim, H.A., 2020. The Influence of Prior Knowledge on Learning Scientific Terminology: A Corpus-Based Cognitive Linguistic Study of ACCELERATION in Arabic and English. *Arab World English* ***Journal for Translation and Literary Studies,*** *4*(1), 148–160. doi: http://dx.doi.org/10.24093/awejtls/vol4no1.12.

Lakoff, G., 1993. The Contemporary Theory of Metaphor. In A. Ortony (Ed.), ***Metaphor and Thought*** (2nd ed., pp. 202–251). Cambridge: Cambridge University Press.

Lakoff, G., 2008. ***Women, Fire, and Dangerous Things:*** What Categories Reveal About the Mind. Chicago and London: The University of Chicago Press. (Original work published 1987)

Lakoff, G. and Johnson, M., 2008. *Metaphors We Live by*. Chicago and London: The University of Chicago Press. (Original work published 1980)

Lakoff, G. and Turner, M., 2009. ***More than Cool Reason: A Field Guide to Poetic Metaphor.*** Chicago and London: The University of Chicago Press. (Original work published 1989)

Langacker, R.W., 1987. ***Foundations of Cognitive Grammar: Theoretical Prerequisites*** (Vol. 1). California: Stanford University Press.

Logan, P., 1981. Language and Physics. *Physics Education*, 16.

Loo, S.P., 2007. The Two Cultures of Science: On Language-Culture Incommensurability Concerning 'Nature' and 'Observation'. *Higher Education Policy, 20*(1), 97–116.

Lund, N., 2014. ***Language and Thought.*** London and New York: Routledge. (Original work published 2003)

Lyons, E. and Coyle, A., 2016. ***Analysis of Qualitative Data in Psychology*** (2nd ed.). London: Sage.

Malotki, E., 2011. ***Hopi Time: A Linguistic Analysis of the Temporal Concepts in the Hopi Language.*** Berlin: De Gruyter Mouton. (Original work published 1983)

Michie, M., 2005. Language-Culture Incommensurability in Science in Non-Asian Indigenous Peoples. ***Southeast Asian and Japanese Cultural Influences on the Understanding of Scientific Concepts,*** 171.

Ng, K.T. and Soo, B.N., 2006. Exploring Factors Contributing to Science Learning via Chinese Language. ***Kalbų Studijos,*** 8, 50–57.

Ogawa, M., 1997. Toward an Epic Description of Science Education: Cultural history of Science Education in Japan. ***Effects of Traditional Cosmology on*** *Science Education,* 96–125.

Ogawa, M., 1998. A Cultural History of Science Education in Japan: An Epic Description. In W.W. Cobern (Ed.), *Socio-Cultural Perspectives on Science Education* (pp. 139–161). Dordrecht: Kluwer Academic Publishers.

O'keeffe, A., McCarthy, M. and Carter, R., 2007. ***From Corpus to Classroom: Language Use and Language Teaching.*** Cambridge University Press.

O'Keeffe, A. and McCarthy, M. (Eds.), 2010. ***The Routledge Handbook of Corpus*** *Linguistics.* Routledge.

Patton, M.Q., 2014. ***Qualitative Research and Evaluation Methods*** (4th ed.). US: Sage Publications.

Quezon-Sarmiento, C., 2005. Understanding Incommensurability and **Indeterminacy in Filipino Culture, Language and Scientific Concepts. Southeast Asian and Japanese Cultural Influences on the Understanding of Scientific Concepts, 103. In Saussure, F.d. (1966).** *Course in General Linguistics* (W. Baskin, Trans.). New York: McGraw-Hill Book Company.

Redouane, R., 1998. Arabization in the Moroccan Educational System: Problems and Prospects. *Language, Culture and Curriculum, 11*(2), 195–203.

Rey, A., 2011. ***Dictionnaire Historique de la Langue Française.*** Paris: Le Robert. (Original work published 1992)

Rosch, E., 1975. Cognitive Representations of Semantic Categories. *Journal of* ***Experimental Psychology: General,*** 104(3), 192.

Rosch, E., Mervis, C.B., Gray, W.D., Johnson, D.M. and Boyes-Braem, P., 1976. Basic Objects in Natural Categories. *Cognitive Psychology, 8*(3), 382–439. doi: http://dx.doi.org/10.1016/0010-0285(76)90013-X.

Saeed, J., 2016. *Semantics* (4th ed.). Oxford: Blackwell.

Salah, H.I., 2010. ***At-Tarjamah l-ʿArabiyah wa l-Injiliziya al-Mushkilah wa l-Hal.*** Cairo: Atlas li-n-nashr.

Sapir, E., 2004. ***Language: An Introduction to the Study of Speech.*** Courier Corporation. (Original work published 1921)

Schmitt, N. (Ed.), 2013. *An Introduction to Applied Linguistics* (2nd ed.). London and New York: Routledge.

Silverman, D., 2017. ***Doing Qualitative Research*** (5th ed.). London: SAGE Publications Limited.

Smith, E.E. and Medin, D.L., 2013. *Categories and Concepts* (Vol. 9). Cambridge, MA: Harvard University Press. (Original work published 1981)

Soanes, C. and Hawker, S. (Eds.), 2008. ***Compact Oxford English Dictionary of*** *Current English* (3rd ed.). Oxford: Oxford University Press.

Srikanthan, G. and Dalrymple J., 2003. Developing Alternative Perspectives for Quality in Higher Education. *International Journal of Educational Management, 17*(3), 126–136.

Strömdahl, H., 2007. ***Critical Features of Word Meaning as an Educational Tool in Learning and Teaching Natural Sciences.*** Paper presented at the 13th International Conference on Thinking, 2007, Linköping. http://citeseerx.ist.psu.edu/index

Taylor, J.R., 2003. ***Linguistic Categorisation:*** Prototypes in Linguistic Theory (3rd ed.). Oxford: Oxford University Press.

Trowbridge, D.E. and McDermott, L.C., 1980. Investigation of Student Understanding of the Concept of Velocity in One Dimension. American Journal of Physics, *48*(12), 1020–1028.

Trowbridge, D.E. and McDermott, L.C., 1981. Investigation of Student Understanding of the Concept of Acceleration in One Dimension. *American Journal of Physics, 49*(3), 242–253.

Tversky, B., & Hemenway, K. (1984). Objects, parts, and categories. Journal of Experimental Psychology: General, 113(2), 169-193. https://doi.org/10.1037/0096-3445.113.2.169

Ulewicz, R., 2017. The Role of Stakeholders in Quality Assurance in Higher Education. *Human Resources Management & Ergonomics*, 11(1).

Whorf, B.L., 2012. ***Language, Thought, and Reality: Selected Writings of*** *Benjamin Lee Whorf.* Massachusetts: MIT Press. (Original work published 1956).