TEACHING AVIATION WEATHER VOCABULARY TO ROMANIAN AIR FORCE CADETS – QUALITATIVE ERROR ANALYSIS

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Abstract: *The article provides a qualitative analysis of aeronautical meteorology adult learner errors in ESP. The discussion revolves around a few main vocabulary topics in aeronautical meteorology: precipitation, the atmosphere and their relevant effects for air traffic management. The corpus is based on traditional vocabulary-focused activities: matching and multiple choice lexical reinforcement exercises. Based on a previous quantitative analysis of the same real-life, classroom-produced materials, this approach is meant to provide complementary information concerning the challenges that Romanian undergraduate Air Force cadets have encountered, in an attempt to map noteworthy insecurity areas, to explain why they arise and suggest potential solutions to be integrated in everyday teaching practice.*

Keywords: *metacognition, ESP, aviation weather, error analysis*

1. THEORETICAL BACKGROUND, PURPOSE AND METHODOLOGY

We have previously advocated for the integration of metacognition and error analysis into broader second language (L2) learning frameworks [1], based on groundwork set by recent theoretical developments in Foreign Language Teaching (FLT) [2, 3, 4, 5, 6, 7, 8].

To add to this line of thought, we intend to come up with a series of two-stepped researches – quantitative and qualitative – meant to analyze errors in Aviation English made by Romanian adult (undergraduate-level) learners. Precisely we set out to generate two analyses per classroom-produced corpus, one quantitative, the other, qualitative, to come up with a set of useful conclusions. A first, quantitative step has already been undertaken in the article cited above [1], concerning the quantitative distribution of mistakes around common topics in aeronautical meteorology. The corpus used in the said approach was made out of answers given to traditional matching and multiple-choice exercises.

As the second, complementary interpretation of the first (aviation weather-oriented) corpus, this article provides a qualitative perspective on the errors quantified and mapped in *Teaching Aviation Weather Vocabulary to Romanian Air Force Cadets – Qualitative Error Analysis Based on Matching and Multiple-Choice Exercises* [1], and will rely heavily on our previous results.

Of course, also we legibly build on Ian Stephen Paul Nation and Teresa Mihwa Chung's the idea that topic-centric acquisition is essential in vocabulary acquisition, especially when it comes to specialized lexicon teaching and learning in applied linguistics and English for Specific Purposes (ESP) [9, 10].

But beyond the theories which laid the foundation for our cited article, we will need to make mention of two other directions which provided methodological and theoretical background we use in the present article and which have been instrumental in shaping the necessary framework for our qualitative interpretations.

Concerning methodology, our first concerns were ethical. In this sense, we openly specify that all the materials cited and investigated in the series have been anonymized for data privacy concerns and the learner's permissions to use the materials as corpus for the said research purposes under the condition of anonymity has been obtained *a priori*. Then, in terms of the actual qualitative methods used in this contribution, we followed in the footsteps of seminal contemporary authors in the field [11, 12, 13].

Of course, in addition to the works of reference used in our quantitative approaches, specific theoretical standpoints have articulated our approach, especially as our objective set from the very beginning of the project was for the series to highlight the bearing of first language (mother tongue or L1) interference in FLA, to the ultimate aim of addressing the basic difficulties that Romanian users of ESP in the aviation industry come across during their learning process. Thus, an innovative concept which lies at the very core of our qualitative approach is the concept of mental translation. At the intersection of cognitive psychology, the psychology of language and applied linguistics [14], mental translation has been first defined by Richard G. Kern , as the "mental reprocessing of second language words, phrases, or sentences in the first language forms" [15], i.e., by heavily relying on formal resemblance and displaced/transplanted language structures from L1 into L2. Of course, this leaves room for development and it is a major prerequisite of L2 learning, this also leaves room for mistakes based on false resemblance (e.g., if we only consider the common problem of what is popularly called 'false friends') and dysfunctional, malformed structures (e.g., the wrong use of prefixes/suffixes based on L1 in word-formation, word-order as a major issue in syntax at both phrase and clause/sentence level – and not to mention more subtle, but essential structures such as abbreviations when we consider aviation English). It is no wonder that the concept has had a rather thundering debut (if the pun is to be permitted) in applied linguistics after its emergence with Kern [15] and Cohen [16] during the last two decades [see 16, 17, 18]. Starting with 2020, it has reached classicization in high-authority theoretical sum-ups such as the periodical ones proposed by Routledge/Taylor & Francis Group [see 19] and has just entered the Romanian scientific space [see 20].

2. SUM-UP OF THE PREVIOUS RELATED QUANTITATIVE ANALYSIS

As explained in the first section of this contribution, this is a second article in a series and is meant to complement or accomplish our first two-fold take on Aviation English with a qualitative interpretations of the results entailed by our previous qualitative research of lexical competence in aeronautical meteorology. In the article we have dedicated to the quantitative analysis of vocabulary errors by topic in aviation weather vocabulary as a higher education study subject, titled *Teaching Aviation Weather Vocabulary to Romanian Air Force Cadets – Qualitative Error Analysis Based on Matching and Multiple-Choice Exercises* [1], we have shown that the distribution of errors varies visibly from topic to topic. As we set out to bank on our findings there, a brief presumptive overview of the core quantitative outcomes is unavoidable as the opening act of the upcoming demonstration.

To come up with a highly efficient and legible summary, meant to be as illustrative and user-friendly as possible, we have used a simple freeware online software (Pie Chart Maker, available at https://piechartmaker.co/) to create descriptive pie charts and bar graphs as visual support.

As a general outline of our results, there are three pertinent, quantified error distributions that need to be mentioned as a starting point here. The first distribution – shown in figures 1, 2 and 3 – displays the proportions of what we will call here the "Topic item count", i.e., the comparative quantitative analysis of 'wrongly solved items' around the selected major topics in aviation weather terminology. Mention must also be made that the lexical structures were organized under 3+1 major topics, i.e., Topic 1: Weather and Precipitation (T1-W&P), Topic 2: Air Movement (T2-AM), Topic 3: Sky Cover and Visibility (T3-SC&V), while Topic 4, titled Other* (T4-O*), was supposed to cover for miscellaneous related vocabulary [1].

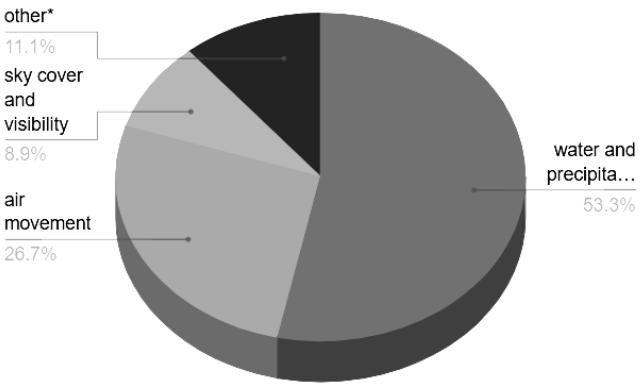


FIG. 1 Topic item count pie (percentage of errors per major topic)

The 'Topic item count pie' above (in Fig. 1) is a comparative visual image of the proportions in which the major topics were represented in the classroom materials used as corpus. This visual shows information which must be taken into account in the interpretation of the error count in the bar graph below (in Fig. 2).

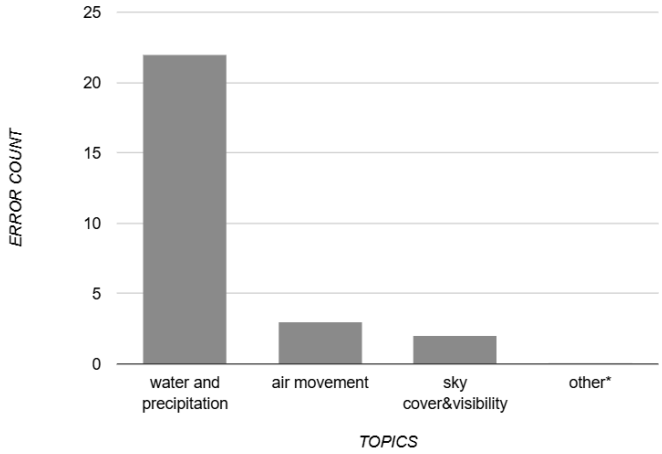


FIG. 2 Topic error count bar graph (number of wrongly solved items per major topic)

The 'Topic error count bar graph' in Fig. 2 shows the number of mistakes related to each topic as shown by the corpus. More specifically, out of 27 errors (versus 94 correct answers out of a total of 121, as shown in another table in the same article) [1], there were 22 errors related to Weather and Precipitation (T1-W&P), 3 to Air Movement (T2-AM), 2 to Sky Cover and Visibility (T3-SC&V), and no errors under miscellaneous structures in the given semantic field (for further details, see [1]). Thus, topics 1, 2 and 3 are the topics deserving a closer look, even though the proportion of error per topic differs greatly.

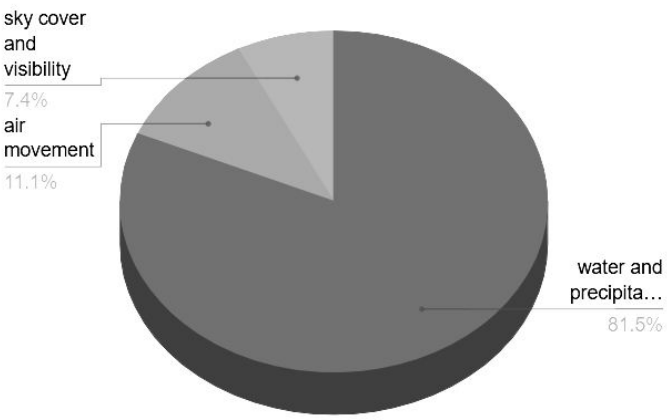


FIG. 3 Topic error count pie

In this sense, the "Topic error count pie" in Fig. 3 clearly displays the semantic field which posed the greatest difficulty to the cadets involved: T1-W&P attracted 81.5% of all mistakes, with T3-SC&V on second place (much less represented in the tests and/or exercises than T2-AM – 8.9% versus 27.6% –, it collected a comparable error count; as the figure shows, T4-O* is not represented at all on the error chart at a relatively higher level of representation than both T2 and T3). But as a first qualitative remark, note must also be taken that the vocabulary under T4 is by definition less specialized and less technical than the other three.

The second relevant distribution based on this quick outline – shown in figures 4, 5 and 6 – displays the proportions of errors per sub-topics. Under T1-W&P, we had organized the following sub-topics: T1.1-METAR codes, T1.2-buildup, T1.3-snow/ice, T1.4-runway conditions; under T2-AM: T2.1-wind, T2.2-turbulence and chop; and finally, under T3, given the low representation of the topic, we had organized no sub-categories [1]. Under Figure 4 we generated an visual presentation of the mistake count per each sub-topic.

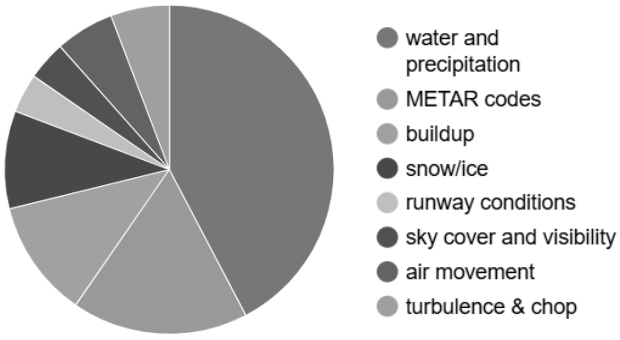
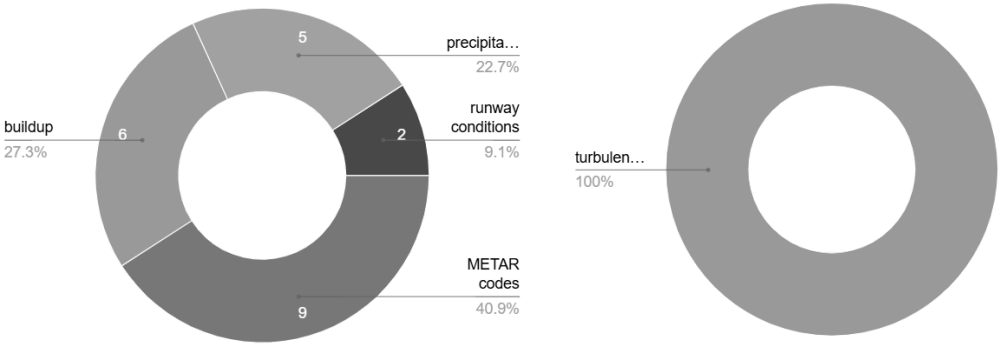


FIG. 4 General sub-topic proportions (number of wrongly solved items per each sub-topic)

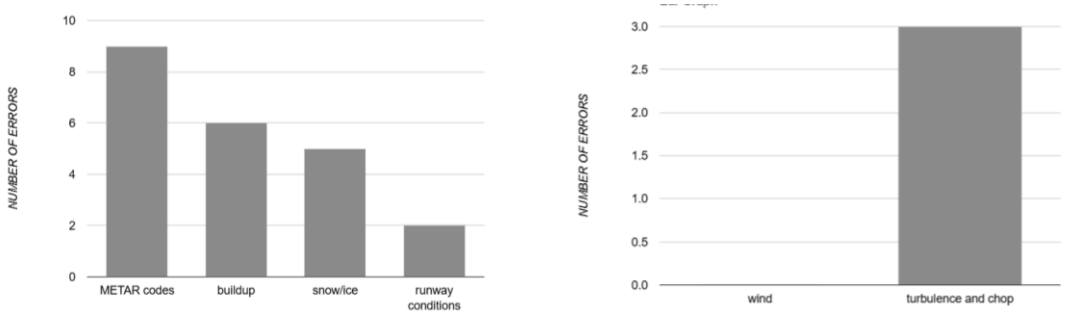
However, it is also relevant to have a closer look at the error count under each sub-topic as organized per each of the major topics dissociated as such – major topics T1-W&P and T2-AM (Fig. 4).



(a) (b)

FIG. 4 Error count proportions (percentages) for each of the sub-topics under major topics T1-W&P (a) and T2-AM (b).

While under T2-AM, the only semantic field causing visible difficulty was T2.2-turbulence and chop, under T1-W&P there is a more proportional distribution of errors, with runway conditions causing the smallest number of problems. The bar graphs below (in Fig. 5) display the numeric value of the same comparative proportions of T1 and T3 sub-topics.



(a) (b)

FIG. 5 Error count for each of the sub-topics under T1-W&P (a) and T3-SC&V (b).

Given the summary of results in this section, what we need to considered under the qualitative analysis are the three major topics covering Weather & Precipitation vocabulary (T1-W&P), Air Movement (T2-AM), and Sky Cover & Visibility (T3-SC&V), with a higher focus on T1 sub-topics in the following order of their relevance T1.1-METAR codes, T1.2-buildup, T1.3-snow/ice, T1.4-runway conditions and T3.2-turbulence and chop. However, T2 will also be briefly discussed, under both sub-topics, as well as T4-Other*.

3. QUALITATIVE ANALYSIS

3.1 Overview. Even though the general proportion of errors among against the total number of answers is rather low (27 wrong answers out of 121, i.e., a total error percentage of 32.67%), considering the degree of specialization of the language structures involved, certain vocabulary fields and terminologies seem to require special attention. Leading, with a umber of 22 errors out of the total of 27 is the semantic field of weather and precipitation [1]. Out of these, METAR codes ranked first, with 9 mistakes, buildup resulted in a number of 6 mistakes, snow and ice caused a similar proportion of 5 mistakes.

Under air movement, the semantic field of winds was fully unproblematic, while turbulence and chop ranked 4th with 3 failed answers. Runway conditions caused by liquid precipitation and errors related to sky cover and visibility both counted 2 wrong answers, ranking last. In what follows, we will analyze each problematic sub-topic and we will also interpret the non-problematic character of T2.1-Wind and T4-Other*.

3.2 The semantic field of weather and precipitation: T1.1-METAR codes. Most mistakes under Topic 1 were related to METAR codes. A closer look at the corpus shows that all occurrences concern almost all the freezing and frozen precipitation types (phases) included in the items, even though the subjects were aware of the codes based on previous knowledge in specialty-related disciplines. According to our observation, GR (hail) is often confused with PL (ice pellets), GS (graupel, also called snow pellets or small hail) is also confused with GR (hail), less frequently, FZRA (freezing rain) is also mistaken for GS; IC (diamond dust / ice crystals) and GR (hail) are also confusing.

Of course, at least two visible explanations can be found here. One major difficulty is generated (with a general term) by form. First, the presence and configuration of the codes themselves is difficult to handle for Romanian users: the chosen acronyms and/or code descriptions do not only resemble greatly (especially GR, GS, hail/GR and small hail/GS, or PL/ice pellets and GS/snow pellets); the descriptors also alternate (hail/GR vs. small hail/snow pellets/GS vs. ice pellets/PL); moreover, there is no connection between the English noun phrases and the initials/letters in the acronym (IC for diamond dust is a further example here, to add to the other illustrations displayed above); to add to all of that, they do not resemble the Romanian terminology at all – not even when such terminology is present.

Thus, as far as form is concerned, the teacher may explain that GR and GS are based on the French words for hail (*grêle*), while in the USA it includes small hail, and again, on the French word for small hail (*grésil*), respectively; they may insist on these issues during practice and reinforcement exercises. But they will remain problematic for most learners and sometimes, they will always cause the entry-level Professor to work extra to remember them.

Obviously, the other difficulty (i.e., the lack of corresponding vocabulary when it comes to fine-tuned terminological discriminations) is cultural in nature: while English has a wide range of precision fin-tunings when it comes to all precipitation types (be it liquid, freezing or frozen), the Romanian vocabulary is much poorer, which even generates problems in specialist dictionaries. For example, the Second Edition (issued in 2014) of the Meteorologic Dictionary (*Dicționar Meteorologic*) authored by Runcanu *et al.* [21] is fairly unable to make some of these distinctions for sheer lack of differentiable Romanian terms. As one example out of many regarding precipitation, it provides the equivalent "măzăriche moale" (where "moale" means soft) for small hail/snow pellets/GS, but for "măzăriche tare" (where "tare" means hard/solid/dense), it provides both ice pellets and small hail, that is to say, snow pellets as equivalents, while the genus "măzăriche" also corresponds to "small hail" [21]. The layer of cultural difference is probably a double, superimposed layer: while the British climate may have originally resulted in richer vocabulary concerning precipitation, a contemporary cultural feature added greatly to it as far as aviation weather terms are concerned: the fact that English remains the main international language of aviation in general, with some terms never being used in vernacular languages – and the vocabulary of METAR is one of them, just like radiotelephony phraseology and other aviation-related codes (e.g., codes related to sky cover), including the above-mentioned weather phenomena as designed by ICAO (the International Civil Aviation Organization) and other international organizations. Thus, there wasn't much use in actually setting off on a lookout for local equivalents.

From another perspective and as a side remark, it also relevant to mention that most of these errors occurred with the same subjects, mainly subjects A8 and A9, followed by A10 (the last with significantly fewer mistakes, i.e., one mistake concerning IC and GR). Thus, learner plain English competence may as well paly a role here, as well as their cognitive skills, psychological profile etc. Lack of personal interest or poor learning techniques might also be taken into consideration, while lack of professional interest cannot (they major as Aeronautical Meteorology officers).

3.3 The semantic field of weather and precipitation: T1.2-buildup, T1.3-snow/ice, and T1.4 runway conditions. "Compacted snow", "snow bank", "snow rut", "snow drift", "pool of water", "standing water" and "puddle" generated most of the difficulties around water, ice and snow buildups and runway conditions, with some students becoming totally undecisive or marking several or all of the answers as correct. Students A8 and A10 also found these vocabulary items difficult to handle as well, with A10 marking all four answers in a multiple choice 4-answer grid, and A8 marking two wrong answers out of four. Other students (B3) made less serious mistakes, e.g. confusing such rather similar terms as "compacted snow" and "snow bank".

These noun phrases are rather plain English structures, so one should expect them to seem friendlier to learners than what the results show. However, there is one rather clear explanation here as well (besides of the fact that some terms are rather similar, as shown): it is the lack of corresponding terms in the subjects' mother tongue (L1) that generates these difficulties: "bank" exists as "bancă" (a financial economic agent – which is also a paronym of the Romanian word for "bench") or seems similar to "banc" (standing for a heap of sand, mud, or cobbles, but also for a group of fish or other marine life forms); "rut" is a false friend of the Romanian "rut", meaning sexual activity period in mammals; "drift" has no semantically similar equivalent in context, and so on. Thus, the lack of correspondents in L1 for these plain, but less usual noun heads affect the legibility of the entire phrases, especially for lower-intermediate students.

3.4 The semantic field of air movement: T2.1-wind. Wind-related vocabulary structures were fully unproblematic for good reason: most of the specialist terminology is extremely similar and recognizable in form based on L1, e.g. anabatic (L2/EFL) – anabatic (L1), catabatic (L2/EFL) – catabatic (L1), geostrophic (L2/EFL) – geostrofic (L1) etc. Other terms are easily understood based on basic-level plain English knowledge, e.g. downdraft or down draught vs. updraft or up draught, veering wind, crosswind etc. Therefore, formal similarity and the basic intelligibility of noun phrase elements, as well as cultural correspondence can account for the lack of challenging vocabulary management.

3.5 The semantic field of air movement: T2.1-turbulence and chop. In this case, most errors revolved around confusions between semantically close noun phrase designators in the Beauford Scale, such as moderate versus severe turbulence. Two rather competent (upper intermediate-level) cadets displayed insecurities or even faulty matches in this area (C1 and C3). It may be that the modifiers were processed as unspecific (even though similar terms in both form and meaning exist in Romanian as well: "moderat" and "sever"), but it is likelier (given the strong L1-L2 correspondence) that the main difficulty was generated here by the poor acquisition of specialist definitions than lack of English proficiency – in the sense that the terms were understood, but the phrases were incorrectly associated with specialized definitions due to the poor internalization of and/or interest in the corresponding specialist knowledge (especially since for C1 and C3, the given practice groups major in ATC and air staff, which makes meteorology adjacent to their main specialist language corpus).

3.6 The semantic field of sky cover and visibility. METAR cloud coverage codes were again responsible for the errors committed under this topic. BKN (broken) and SCT (scattered) were the most problematic and were confused for one another by students whose main qualification is air staff – so again, the vocabulary is related, but adjacent to their targeted job profile, which could account for the poor management of knowledge in this area. Just like with turbulence and chop, the definitions seemed to be mor challenging than the abbreviated phrases, since again, the two terms are next to each other in the METAR scale.

3.7 Miscellaneous related vocabulary structures. A small number of similar and related structures in Aviation English were introduced in the tests and exercises in the corpus for safe discrimination, such as "drift" (as opposed to "snow drift", for example). These differentiations resulted in a total number of zero mistakes, which shows that the subjects have a firm grip on and outstanding control over the separation of major specialist vocabulary areas withing the field of Aviation English.

4. LIMITATIONS

One limitation of the present study has already become visible under the analyses in section 3, while not readily obvious under the quantitative interpretation alone. It is the fact that besides individual difference in proficiency levels as far as plain English is concerned (inducing unavoidable effects in the management of specialized vocabulary), student motivation in seriously dealing with vocabulary which seems less important or adjacent to one's targeted sub-specialty may also affect results, such as some of the mistakes under topics 2 and 3 (concerning air movement and sky cover/visibility conditions, respectively).

Another (somewhat related) limitation is the distribution of items per topic(s), as weather and precipitation hold the major focus with more than 80 percent of the total number of items involved. One justification of this fact is simply that some of the materials were not originally designed with research in mind (as corpus); as they were deemed relevant, they were added to the main corpus. Another (the main) explanation is the intentional focus on precipitation in class (as also reflected by the approved curriculum and course syllabus) since the topic perceptibly stood out as a special challenge we have noticed cadets in various generations tend to struggle against during class activities and exams.

We also intend to further develop this pre-research experiment (done within the framework and set timeline of a research project meant to support further analyses – for clarification, see the Acknowledgement section), as new generations of cadets agree to furnish additional material.

5. CONCLUSIONS

The complementary qualitative analysis provided by this second fold in our research in the English of aeronautical meteorology has proven its efficiency and has demonstrated three main points. On the one hand, it has highlighted Topic 1 – Weather and Precipitation as the major difficulty area for Romanian learners. The interpretation of the errors can provide both tutors and learners with food for thought as far as classroom solutions, teaching/study methods and points of interest are concerned, among which the reinforcement of knowledge through intense exercise may meet the need to introduce a few advanced language theory notions such as noun phrases and their functioning, or even to research abbreviations and their form and/or contextual use in Aviation English.

Techniques such as the keyword technique or word part analysis suggested by Nation need to be made good use of [10] in congruence with the more general (and useful) topic-centered teaching of vocabulary. Syllabus adjustment and specific class material generation are also crucial, as some topics may prove to be more challenging than others.

At the same time, it also showed the role of L1 interference and mental translation in language acquisition. Therefore, classroom activities should also focus on shortlisting and showcasing essential areas of interference, with a focus on form and culture as the core points of interest in classroom materials design and research, at all times, including as part of the course provider's (new) language input methodology. Terms such as 'false friend' or 'paronym', 'homonym', 'homograph', perhaps even 'mental translation' [15] and/or 'semantic transfer' as defined by Jiang [17] may be of use in the classroom, as concisely explained as possible. Last but not least, incongruencies between L2 and L1 must be spotlighted and more than that – explained, for students to be given the possibility to logically associate, contextualize and remember difficult terminology. This is not the same as using L1 in the classroom to redouble L2 immersion: this is about providing logical support in English as before, but while referring (or even eliciting) wrongful metal translations from one's students to then provide them with input they may feel (or intuitively become) further psychologically motivated to remember.

Last but not least, the present qualitative complement to the quantitative analysis of errors has shown that the cultural dimension of knowledge which needs to be integrated here is much more relevant than usually expected in the area of what is generally termed as 'technical vocabulary' [9] or ESP (as a sub-branch applied linguistics). And what we mean is not just a simple matter of including elements of etymology (as with the analyzed METAR codes describing precipitation) or considerations around learner psychology: cultural elements are at the root of the semantic-symbolic organization of language as worldview and the general organization of experience and interpretation, a matter of both common and distinctive identity features evolving together or separately in time and space and resulting in equivalence/correspondence or the lack of congruity between L1 and L2 language structures. This realization in both tutors and adult learners seems to be of the essence in associating sign and meaning in general and in opening foreign language acquisition / teaching techniques to self-aware, constructive error analysis and metacognition as suggested by contemporary directions in specialist literature [2, 3, 4, 5, 6, 7, 8].

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