

Portuguese language, didactics and engineering

An (im)probable relationship?

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Abstract— The society of the 21st century has some keywords: globalism, transversality, skills. The realities they refer to affect every scientific area and should not be ignored by education, independently of what is being taught/learned.

Communication is related with all these tendencies. It is global and helps to install globalism. It is transversal, either in verbal or non-verbal form. It develops essential skills.

Furthermore, the mastering of communication in the mother tongue is an essential element in this context, which importance is recognized both in political statements and educational directives, including the Bologna Process, which is now being developed in Higher Education after its adoption during the first decade of this century. Being able to communicate effectively in one's mother tongue – in oral or written form – is an essential component of any profession, and the training necessary to prepare students for their future professional field may contribute to a better domain of the mother tongue.

In this paper, we intend to show that within the teaching/learning of Portuguese as a mother tongue, there are strategies and knowledge that can lead to the development of skills essential to be a good engineer in the 21st century working market and to show how they can be used within the teaching of engineering to contribute to the development of oral and written communication skills in the students.

Keywords— *globalism; transversality; skills; mother tongue; oral and written communication*

I. WHAT CAN ENGINEERING PROVIDE TO THE 21ST CENTURY SOCIETY?

The society of the 21st century presents some features that characterize it: globalism, multiculturalism, multilingualism (in spite of the role played by English as a *lingua franca*), great migrations, almost unlimited access to knowledge mainly due to the use of ICT.

Consequently, life in modern society requires a new model of education centered in the development of skills rather than in the acquisition of knowledge (although the latter keeps its importance) (Sá, Cardoso & Alarcão, 2008).

In an effort to prepare people for such a context, international organizations have been trying to identify and define skills essential to life in an ever changing world, which

must be developed by a new model of Education featuring more engaged students assisted by their teachers (European Commission, 2007: 5-13). These essential – and transversal skills – include some related to traditional scientific areas (*Communication in the mother tongue and foreign languages, Mathematical literacy and basic competences in science and technology, ICT skills*) and others concerning life in a modern society (*Learning to learn, Entrepreneurship, Interpersonal, intercultural and social competencies, Civic competencies and Cultural awareness*).

The Portuguese educational system follows these trends. The first document to feature these tendencies was the *National Curriculum for Basic Education* (Ministério da Educação, 2001), which promoted the development of skills related to knowledge (scientific, technological and cultural) and its use, language (mother tongue and foreign languages), methods and techniques centered in problem solving (looking for information and organizing it, selecting strategies adapted to a specific goal, taking decisions, being autonomous and capable of involvement in team work) and the ability to perceive life in an ecological way.

The more recent document showing such concerns is the *Students' profile for the 21st century* (Gomes *et al.*, 2017), which presents a set of very interesting propositions related with:

- Principles essential to the adaptation to modern society, namely *promotion of a democratic, just and inclusive society, sustainable development, defense of holistic knowledge* capable of providing solutions for social problems, *promotion of a transversal approach of the teaching and learning process* leading to the development of essential skills and lifelong learning, which contributes to the adaptation to an ever changing society;

- The acquisition and development of transversal skills (*Language and texts, Information and communication, Reasoning and problem solving, Critical thinking, Creative thinking, Interpersonal interaction, Aesthetic and artistic sensibility, Technical knowledge and technology, Wellbeing and health, Conscience and mastering of the body and Autonomy and personal development*);

- New directions in teaching capable of promoting those principles and contributing to the development of such skills, including cooperation and collaboration, integration of several kinds of knowledge, projects, critical use of several sources of information, use of ICT, dynamic activities (implying choices, the discussion of different perspectives, problem solving and decision making, relating the acquisition of knowledge and the development of transversal skills within situations present in everyday life and the sociocultural and environmental context) and experimenting techniques, instruments and attitudes at work promoting observation and questioning of the reality and integration of knowledge from several fields.

These documents concern Basic and Secondary Education, but the conceptions underlying them also affect Higher Education (cf. Sá, 2016). New degrees created by the implementation of the Bologna Process focus on the development of skills independently of the scientific area, promote lifelong learning and the ability to adapt to diverse contexts and demand new teaching and assessment methods.

What kind of relation is there between this political and educational context and engineering and its teaching (and learning)?

It is easy to understand that engineering is:

- Related with Mathematical literacy and basic competences in science and technology (European Commission, 2007);

- Contributes to the acquisition of scientific and technological knowledge and its use and promotes methods and techniques centered in problem solving (looking for information and organizing it, selecting strategies adapted to a specific goal, taking decisions, being autonomous and capable of involvement in team work) (Ministério da Educação, 2001);

- Leads to the acquisition and development of transversal skills such as *Reasoning and problem solving, Critical thinking* and *Interpersonal interaction* (Gomes et al., 2017);

- May benefit from new directions in teaching based on cooperation and collaboration, projects, the integration of several kinds of knowledge, critical use of several sources of information and ICT, dynamic activities (implying choices, the discussion of different perspectives, problem solving and decision making, relating the acquisition of knowledge and the development of transversal skills with situations present in everyday life and the sociocultural and environmental context and experimenting techniques, instruments and attitudes at work promoting observation and questioning of the reality) (Gomes et al., 2017).

Therefore, being an engineer or teaching and learning engineering are ways of taking part in this political, social and educational movement.

II. WHAT CAN PORTUGUESE LANGUAGE AS A MOTHER TONGUE GIVE TO ENGINEERS?

First of all the mastering of the mother tongue – Portuguese, in this case – is also an important part of the “revolution” described above, as:

- It is related with skills essential to life in 21st century:

- *Communication in the mother tongue, Interpersonal, intercultural and social competences* and *Cultural awareness* (European Commission, 2007),
- *Knowledge* (scientific, technological and cultural) and its use and *Methods and techniques centered in problem solving* (looking for information and organizing it, selecting strategies adapted to a specific goal and taking decisions) (Ministério da Educação, 2001);
- *Language and texts, Information and communication, Reasoning and problem solving, Critical thinking, Creative thinking, Interpersonal interaction, Aesthetic and artistic sensibility* and *Technical knowledge and technology* (Gomes et al., 2017);

- It may benefit from new directions in teaching, capable of contributing to the development of such skills, including critical use of several sources of information, use of ICT, integration of several kinds of knowledge, projects, cooperation and collaboration, dynamic activities (implying choices, the discussion of different perspectives, problem solving and decision making and relating the acquisition of knowledge and the development of transversal competencies with situations present in everyday life and the sociocultural and environmental context) (Gomes et al., 2017).

Then no one can deny that the mastering of the mother tongue – namely being proficient in oral and written communication – contributes to the development of transversal skills, so called because they are present in all our activities, either professional, social or academic (cf. Rey, 1996).

Consequently, recent research in Education defends the transversal approach of teaching and learning the mother tongue, which includes two directions (Sá, 2009a, 2012, 2017; Valadares, 2003):

- Teaching and learning the mother tongue to develop transversal skills related with the interaction between oral communication, reading and writing and their intertwining with the study of grammar and literature;

- Being aware of the fact that teaching and learning other subjects may develop skills which are important to the mastering of the mother tongue, such as, for example, *Reasoning and problem solving, Critical thinking, Creative thinking, Aesthetic and artistic sensibility* and *Technical knowledge and technology*.

III. WHAT CONTRIBUTION CAN DIDACTICS GIVE TO THE TEACHING OF ENGINEERING?

We have already stated that being proficient in oral and written communication is essential to academic success and – above all – to be an active and critical citizen. International documents designed to determine educational policies and the curricula created for the various domains of knowledge emphasize the importance of these skills and their relation with the mastering of the mother tongue.

Nevertheless international studies concerning literacy levels show great problems on this field, which affect not only adults integrated in the working world, but also the adolescents who finish compulsive education and even young adults attending Higher Education. Unfortunately all the measures taken to solve these problems seem to fail.

As a researcher in Education and Didactics, we have been trying to present some suggestions to teach and assess oral and written communication (namely in formative terms) both in Basic and Secondary Education. The latter can be used in Higher Education to increase the proficiency in oral and written communication of students attending degrees on any subject including engineering.

IV. HOW CAN THE TEACHING OF ENGINEERING CONTRIBUTE TO THE DEVELOPMENT OF ORAL AND WRITTEN COMMUNICATION SKILLS IN THE STUDENTS?

While reflecting on how Portuguese should be included in the curricula of other scientific areas in Higher Education, several questions arise: Should it appear as a separated discipline or should communication skills development be embedded within technical disciplines? Should Portuguese learning be mandatory or optional? Who should teach Portuguese to future professionals? Language professors? Multidisciplinary teams including language experts? Technical areas professors?

We believe that every teacher is related with the teaching of Portuguese: experts in mother tongue teach Portuguese and experts in other scientific areas teach in Portuguese. In both cases, the teacher can develop communication skills in his/her students (Sá, 2012). Thus, all the suggestions presented in this paper are proposed to technical areas professors who feel fit to develop skills in oral and written communication in their students.

When we deal with oral communication (which engineers must use for example to collect information from oral presentations or to present their projects to clients and defend them), we must take into account several aspects (Luna, 2016):

- In general, mechanisms of linguistic, encyclopaedic and textual nature;

- In what concerns comprehension,

- Three phases (pre-listening, listening and post-listening),

- Several strategies (previewing ideas, formulating hypotheses, apprehending the ideas in the discourse, identifying the main ideas, making inferences and monitoring the comprehension);

- In what concerns expression,

- Several levels (phonetic-phonological, related to the use of intonation to be more expressive and emphasize certain aspects of the oral discourse; lexico-semantic, related to the use of vocabulary suitable to the situation; morphosyntactic, associated to the grammatical correction of discourse; textual, creating the coherence and cohesion of the discourse, which is essential for a good comprehension of what we say),
- Three operations (planning the discourse, producing it and revising it for the final presentation).

All these aspects of oral discourse must be taken into account and trained, within the teaching/learning of engineering. That can be done exploring oral texts (for example, podcasts or videos/documentaries presented in youtube on important topics or oral tutorials to perform a specific task) or preparing oral presentations using simple strategies (cf. Sá, 2018), which will show very productive at medium term, as presented in the following table:

TABLE 1 – SUGGESTIONS FOR THE DEVELOPMENT OF ORAL COMMUNICATION WITHIN THE TEACHING OF ENGINEERING

Skills	Activities
Oral comprehension	<p>Pre-listening phase</p> <ul style="list-style-type: none"> • Present the oral document to be explored allowing the students to preview ideas presented in the text and/or formulate hypotheses on its content <p>- Listening phase</p> <ul style="list-style-type: none"> • Ask the students to take notes <p>- Post-listening phase</p> <ul style="list-style-type: none"> • Discuss the information the students gathered and make them compare it to the previews and hypotheses • Make them prepare a glossary and/or a summary of the main information on the topic for future use
Oral expression	<p>- Planning phase</p> <ul style="list-style-type: none"> • Ask the students to do research on the topic • Advise the students <ul style="list-style-type: none"> ✓ To use a glossary or summary of the main information on the topic previously produced ✓ To select carefully the information to be included in the oral presentation ✓ To organize their ideas <p>- Production phase</p> <ul style="list-style-type: none"> • Advise the students to <ul style="list-style-type: none"> ✓ Elaborate a document in PowerPoint to support the oral presentation, taking into account several mechanisms of oral

	<p>communication (of linguistic, encyclopedic and textual nature)</p> <p>✓ To train the oral presentation taking into account the different levels of oral expression (of phonetic-phonological, lexical-semantic, morphosyntactical and textual nature)</p> <p>- Revision phase</p> <ul style="list-style-type: none"> • After the oral presentation done by the students, <ul style="list-style-type: none"> ✓ Discuss it with them (also involving the other students in the class) ✓ Make them identify the strengths and weaknesses in their oral presentation to maintain the first ones and solve the latter
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When we deal with written communication (which engineers must use for instance to read texts on topics concerning their area of knowledge or write their own documents others will read), we also must take into account several aspects.

In what concerns written comprehension, one must consider (Sá, 2014):

- Three phases (pre-reading, reading and post-reading),

- Several strategies (activating previous knowledge on the topic dealt with in the text, previewing ideas, formulating hypotheses, reading attentively the text, underlining parts of it, taking notes, making inferences, monitoring the comprehension, summarising what the person understood, doing research on the concepts and ideas which were not understood and identifying the type/genre of text in order to apprehend the ideas in it and identify its main ideas).

All the aspects of reading must be taken into account and may be trained, using simple didactic strategies (Sá, 2009b):

- To train the apprehension of ideas, one can focus on

- Elements of the text (words, phrases, sentences, paragraphs) and the relations among them (explicit or implicit, the latter demanding the elaboration of inferences),
- The ideas presented by parts of the text, by paraphrasing them, answering questions on the text, formulating questions others must answer;

- To train the identification of main ideas, one can focus on:

- The identification of the main topic of the text (using elements such as the title or a summary that presents it),

- The distinction between main and secondary ideas (namely answering questions on the text or formulating them or even summarizing the text);

- To train the identification of the type/genre of the text, one must focus on

- The information in the text corresponding to each category of its structure,
- Linguistic marks, which guide the reader, present at the beginning of the text, closing it or giving temporal, spatial and logical information along it.

In what concerns teaching future ingeniers, for reading the teacher can train the students making them explore written texts in several phases (cf. Sá, 2018), as shown in the table:

TABLE II – SUGGESTIONS FOR THE DEVELOPMENT OF WRITTEN COMPREHENSION WITHIN THE TEACHING OF ENGINEERING

Skills	Activities
Reading	<p>- Pre-reading phase</p> <ul style="list-style-type: none"> • Present the written document to be explored allowing the students to preview ideas presented in the text and/or formulate hypotheses on its content <p>- Reading phase</p> <ul style="list-style-type: none"> • Ask the students to take notes <p>- Post-reading phase</p> <ul style="list-style-type: none"> • Ask the students to paraphrase parts of the text • Discuss the information the students gathered and make them compare it to the previews and hypotheses • Make them prepare a glossary and/or a summary of the main information on the topic for future use

In what concerns written expression (writing), one must take into account three operations and several levels of the text (Reuter, 1996):

- Planning the text, which includes

- The conception of the text and activation of pertinent knowledge related with its main topic,
- The organization of the ideas, namely determining their hierarchy,
- The adaptation of the text to the characteristics of the expected readers;

- Writing the text, which includes

- Dealing with global and local aspects of its elaboration,
- Guaranteeing its coherence and cohesion;

- Revising the text, both at global and local level, to identify flaws in it and eliminate them.

For written expression, the teacher may take profit of the texts the students produce (such as reports of experiments done in the laboratory) taking into account the three operations (cf. Sá, 2018), as suggested in the next table:

TABLE III – SUGGESTIONS FOR THE DEVELOPMENT OF WRITTEN PRODUCTION WITHIN THE TEACHING OF ENGINEERING

Skills	Activities
Writing	<ul style="list-style-type: none"> - Planning phase <ul style="list-style-type: none"> • Ask the students to elaborate a guideline to write the text determining the information which will be presented and its organization (including the hierarchy of the ideas) - Production phase <ul style="list-style-type: none"> • Advise the students to take into account <ul style="list-style-type: none"> ✓ Global aspects (structure of the text, ideas, their articulation and hierarchy) ✓ Local aspects (coherence, cohesion, vocabulary, spelling and punctuation) - Revision of the text <ul style="list-style-type: none"> • Advise to students to reread and review their text taking into account global and local aspects

Assessment is also an important part of the teaching/learning process. The teacher of ingeneering may include in this part of the process elements that will help to determine his/her students' proficiency in verbal communication without much more work, as shown in the last table:

TABLE IV – SUGGESTIONS FOR THE ASSESSMENT OF PERFORMANCE IN ORAL AND WRITTEN COMMUNICATION WITHIN THE TEACHING OF ENGINEERING

Skills	Aspects to assess
Oral comprehension	<ul style="list-style-type: none"> - Before listening <ul style="list-style-type: none"> • Previewing ideas • Formulating hypotheses - While listening <ul style="list-style-type: none"> • Taking notes - After listening <ul style="list-style-type: none"> • Looking for the sense of words/phrases/sentences and concepts and relations between them the student didn't understand • Aprehending explicit and implicit information (the latter implying the elaboration of inferences) • Comparing the ideas previewed and the hypotheses formulated with the information gathered • Identifying the main ideas of the text • Relistening to the text, if necessary • Identifying the type/genre of the text
Oral comprehension	<ul style="list-style-type: none"> - Adapting the voice to the circumstances - Having a clear diction - Using the right intonation - Adopting adequate face expressions and body language - Selecting a type/genre of text adequate to the circumstances of communication - Respecting the characteristics of the selected type/genre of text - Using adequate vocabulary

	<ul style="list-style-type: none"> - Presenting relevant information - Correctly articulating the discourse in logical terms - Presenting a cohesive discourse
Reading	<ul style="list-style-type: none"> - Before reading <ul style="list-style-type: none"> • Previewing ideas • Formulating hypotheses - While reading <ul style="list-style-type: none"> • Taking notes - After reading <ul style="list-style-type: none"> • Looking for the sense of words/phrases/sentences and concepts and relations between them the student couldn't understand • Understanding explicit and implicit information (the latter implying the elaboration of inferences) • Comparing the ideas previewed and the hypotheses formulated with the information gathered • Identifying the main ideas of the text • Rereading the text, if necessary • Identifying the type/genre of the text
Writing	<ul style="list-style-type: none"> - Selecting a type/genre of text adequate to the circumstances of communication - Respecting the characteristics of the selected type/genre of text - Using adequate vocabulary - Presenting relevant information - Correctly organizing the information (namely in hierarchical terms) - Presenting a cohesive discourse (through the use of coreference and verbal concordancy and regency) - Correctly using punctuation and spelling

Last but not least, the development of these competencies may engage the students in individual or team work (thus developing autonomy and collaboration) and assessment may be formative (when the teacher uses it to identify the problems in the students' performance and help them to solve them or makes them assess their own work).

V. CONCLUSION

In this paper, we discuss several issues concerning the contribution of education for the preparation for life in the 21st century society. Among those reflections, we include a reference to the way Portuguese and the development of communication skills should be included in engineering degrees' curricula. At the same time, we rise important questions related with multidisciplinary education, by proposing strategies to use within the teaching of engineering to develop and assess communication skills.

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