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Introduction

In the world of globally interconnected engineering activities, the English language has become vital for biotechnology engineers to perform their professional activities. Biotechnology is already giving a basic structure to the sustainable development of agriculture, forestry, and fisheries, as well as the food and other primary product-related industries. It has tremendous potential for impacting global food security, human and animal health, environmental health, and the overall livelihood of mankind (Serageldin,
1999). As globalization directly affects the industry's needs, a global engineer in biotechnology and related fields should be able to easily cross national and cultural needs. In order to accomplish this, the competence of a successful engineer in the 21st century, besides being competent in their primary field of expertise, includes good foreign language skills (Grünwald, 1999).

English has been widely accepted as the most widespread language in the world and the major language of international business, diplomacy, and science and the professions (Kitao, 1996). Frequent are examples of English as the main means of communication among the engineers in different projects (El-Raghy, 1999; Riemer, 2002). Nowadays, the universities and institutions offering biotechnology engineering (with a focus on agriculture and food technology) courses in Europe, and under the roof of different European Commission Erasmus+ programs, and Asia also offer biotechnology engineering courses in English. Courses in English for specific biotechnology engineering purposes enhance English language training and the engineers' communication skills. Such specialized courses achieve more in the education of engineers in general, including biotechnology engineers, as they focus the learners' attention on the particular terminology and communication skills required in the relevant professional field.

Biotechnology differs from other disciplines such as history, literary studies, and other fields of engineering (e.g. electrical engineering, computer engineering) because it explores the use of living systems and organisms to develop or make products or any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use in producing raw food and feed, and food processing. The language in biotechnology engineering reflects the characteristics of the discipline’s inherent phenomena as well as the methods and processes employed.

Biotechnology engineers: the skills required

Biotechnology engineers apply engineering principles of science and technology, as well as knowledge of biotechnology practices, to solve problems relating to sustainable agricultural production, the environmental impacts of intensive agriculture, the post-harvest handling of agricultural products, and the processing of raw food to obtain the desired food product.

There is a need for an in-depth understanding of biology, chemistry, plants, soil, weeds, quality assurance procedures (laboratory chemical analyses, physical analyses, controls), food preparation, laboratory equipment, food safety standards, data analysis, market and consumer demands, as well as critical thinking, problem-solving and integrative thinking, good oral and written communication skills, foreign language knowledge of adequate grammar and vocabulary use and language skills (reading, listening, speaking, writing) - English language being the core foreign language in international business cooperation, as elaborated in the previous section.

For the realization of communicative intentions, users bring to bear a more specifically language-related communicative competence, in its narrower sense, having the following components: linguistic competence, sociolinguistic competence, and pragmatic competence (Common European Framework of Reference for Languages - CEFR)**.** In short, *linguistic competence* refers to: 1) the knowledge and ability to use the vocabulary of a language (lexical competence); 2) the grammatical resources of language (grammatical competence) including organization of words and word formation (morphology) and organization of words into sentences (syntax); 3) semantic competence which deals with the learner's awareness and control of the organization of meaning (including reference, connotations, synonymy/antonymy, hyponymy, collocation, translation equivalence, etc.); 4) phonological competence involves a knowledge of and skill in the perception and production of the sound units and their realization in particular contexts, distinctive features (e.g. voicing, rounding, nasality, plosion), syllable structure (e.g. word stress, word tone), sentence stress and rhythm and intonation, phonetic reduction (e.g. assimilation, elision); 5) orthographic competence involves a knowledge of and skill in the perception and production of the symbols of which written texts are composed; and 6) orthoepic competence refers to the ability to produce a correct pronunciation from the written form. *Sociolinguistic competence* is concerned with the knowledge and skills required to deal with the social dimension of language use involving linguistic markers of social relations (e.g. use and choice of greetings, of address forms); politeness conventions; expressions of folk-wisdom; register differences (e.g. formal, neutral, informal, familiar, intimate); and dialect and accent (social class, regional provenance, national origin, occupational group). *Pragmatic competence* is concerned with the user/learner's knowledge of the principles according to which messages are: 1) organized, structured, and arranged (discourse competence) - includes knowledge of and ability to control the ordering of sentences in terms of topic/focus, cause/effect, thematic organization, coherence and cohesion, logical ordering, style; and 2) used to perform communicative functions (functional competence) through microfunctions (e.g. identifying, correcting, reporting, agreeing/disagreeing, expressing intentions, showing interest/disappointment/fear/worry, suggesting, requesting, warning, addressing, greetings, etc.) and macrofunctions (e.g. description, narration, commentary, explanation, demonstration, instruction, argumentation, etc.). Two quality factors which determine the functional success of learners are necessary to be mentioned here - fluency, or the ability to articulate and keep going when one lands on a dead end, and propositional precision, or the ability to formulate thoughts so as to make one's meaning clear. *Strategic competence*, considered a part of communicative language usage, involves the application of communicative strategies which can be seen as the application of metacognitive principles of pre-planning, execution, monitoring, and repair action to the different kinds of communicative activities: reception, interaction, production, and mediation. Moreover, nonverbal communication is also considered a segment of communicative language usage and involves practical activities such as eye direction, finger-pointing, paralinguistic elements (e.g. gestures, facial expression, body posture, eye contact, proxemics),

nonlinguistic elements such as the use of extra-linguistic speech-sounds (e.g. "sh" meaning requesting silence, "ugh" expressing disgust, "tut, tut" expressing disapproval).

English language in biotechnology engineering

Teaching English to prospective biotechnology engineers is demanding in terms of content, methods, and techniques, deciding which are appropriate ones for such an interdisciplinary area in engineering and English. In biotechnology engineering, the issues to be considered concerning using the English language include English (as a foreign language) literacy, content knowledge, language skills (reading/writing, listening/speaking), and strategies characteristic of biotechnology and its sub-disciplines (arable farming, horticulture, fruit growing, animal husbandry, plant protection, and food technology) (Bojović, 2017b). In biotechnology engineering, it is important to attain knowledge about phenomena and to invent and develop solutions to real problems in order to meet human needs for food.

To achieve this goal, the English for specific purposes (ESP) instructors/teachers have to plan the courses they teach and provide the educational materials for them. The educational materials (texts, audio material, and video material) combine technical vocabulary from different fields of science such as botany, in which Latin and Greek words for plants and processes are used (e.g. biennial, perennial, osmosis, photosynthesis), chemistry (e.g. acidity or alkalinity of soil), zoology (e.g. bee-keeping, oviposition), agriculture (e.g. tillage, irrigation, and drainage techniques) or food technology (e.g. caramelization, cryogenic freezing, fermentation).

ESP biotechnology engineering courses

Serbian perspective

Currently, in Serbia there are five academic institutions in the field of biotechnology engineering, with a focus on agriculture and food technology, offering the ESP courses in biotechnology engineering - Faculty of Agriculture of the University of Belgrade, Faculty of Agriculture of the University of Novi Sad, Faculty of Agronomy of the University of Kragujevac, State University of Novi Pazar, and Faculty of Agriculture of the University of Niš. Mostly, the mode of delivery of these courses is face-to-face (f2f). However, during the pandemic caused by Coronavirus (COVID-19), all the institutions responded by offering e-learning ESP biotechnology engineering courses via various video conferencing tools (Cisco Webex Meetings, Zoom, Microsoft Teams, Google Meet) and a Learning Management System (Moodle).

ESP biotechnology courses: Teaching/learning environment

The Faculty of Agronomy of the University of Kragujevac, where the author works, operates a small ESP program for undergraduate students. The ESP program consists of five courses, three of them in the freshmen year, one course in the third, and one in the fourth year of study. The courses are taught by the same instructor, each course for two classroom hours each week. The semesters run two times per year, for 15 weeks, with class sizes generally ranging from 5 to 35 students. The students are usually Serbian citizens, except for mobility students who are, so far, coming from ex-Yugoslav states. The students come from various sub-disciplines, including

agronomy, animal husbandry, fruit growing and viticulture, and food technology. The levels of the students' English language proficiency skills range from A2 (lower intermediate) to C1 (advanced) according to the Common European Framework Reference for Languages (2002).

The mode of the courses' delivery is blended. Blended learning is defined as a combination of face-to-face (F2F) and computer-assisted language learning (CALL) (Neumeier, 2005, p. 164; Stracke, 2007, p. 57). The term *computer-assisted language learning* was substituted with the term *technology* (Sharma & Barrett, 2007, p. 7) which covers a wide range of technologies such as the Internet, CD ROMs, and interactive boards, or with the term online delivery (Dudeney & Hockly, 2007, p. 137).

Why employ blended learning? To motivate students to read various resources, to write using Web 2.0 tools, to create space for them to share their experiences, to encourage informal communication, and provide additional channels for interaction and opportunities for collaboration.

Face-to-face (F2F) foreign language instruction and online language instruction may be blended at different levels (Graham, 2006, pp. 11-13): at the activity level when a learning activity contains both F2F and online learning elements; course-level blending, which is one of the most common ways to blend, where learners are engaged in different online and F2F activities (during the semester, school year) that overlap in time or are sequenced chronologically but not overlapping; then, program-level blending, often occurring in higher education, where, according to one model, the participants/students are offered F2F courses and online courses, while according to another model, all courses prescribed by the program are blended courses; and, finally, institutional-level blending, where students have F2F classes at the beginning and at the end of the course, with online activities in between or where all courses are realized in the online environment during one semester.

ESP biotechnology courses: the blend

The courses employed are course-level blended ESP courses. There were two kinds of blends: the blend of interaction, involving the f2f component and online component, and the blend of tools, including available and free Web 2.0 tools for collaborative work, assignments, corrections, feedback, and discussions.

Before the spring semester in 2020, i.e. before the pandemic crisis caused by Coronavirus (COVID-19), the blended language classes were organized in such a way that the students learned mostly through weekly f2f sessions with their language teacher. During these 15-week sessions, the students read and discussed a variety of material selected on the basis of their interests and relevant content, taking into account their learning needs and future profession. The students were offered a wide range of activities (reading, writing, listening, speaking) to help them develop and improve their language knowledge and language skills. Their work continued in an online environment as individual work and homework. The students used different Web 2.0 tools for communication/collaboration/resources (e.g. Dropbox, Skype, Gmail, Quizlet, YouTube) to complete their assignments and submit them to their teacher. Also, the students were encouraged to develop their English vocabulary using online English dictionaries or mobile application dictionaries. The students used these tools to communicate with the teachers and their peers and to comment on their colleagues' work, mostly through asynchronous communication. Such communication unfolded as mostly asynchronous and sometimes synchronous.

During the spring semester of 2020, the blended mode of delivery had some specificities. The semester started as f2f delivery mode and, when the pandemic measures were introduced in the mid of March 2020, continued as online teaching/learning till the end of May (the end of spring term). Two video conferencing tools (Cisco Webex Meetings and Zoom) and a Learning Management System (Moodle) were used for teaching/learning English. Video conferencing tools were used for synchronous communication between the teacher and the students and among the students, for delivering text materials and vocabulary activities, audio and video materials, using the whiteboard, chat option, and share options. Moodle as an LMS was used for asynchronous learning, additional vocabulary/grammar exercises, reading material, audio/video teaching material, collaborative student work (Wiki, glossary), and other assignments (projects/seminar papers). The fall semester of 2020 was in a similar delivery mode as the spring semester of 2020, with one difference: the video conferencing tool and the main tool for exchanging the messages between the teacher and the students was Microsoft Teams.

English language for biotechnology: the topics

The topics covered in English for specific biotechnology engineering purposes reflect the content relevant to biotechnology engineers. The courses in the freshmen year deal with the introductory topics on botany, applied chemistry, ecology, soil management, crop production (fruit/vegetable/cereals), such as the life cycle of a plant, flower organs and their functions, structure of chemical elements and compounds, fertilizers, types of tillage, irrigation and drainage techniques, livestock feeding and management.

The third-year ESP course "English language in fruit growing and viticulture" covers the problems of fruit systematic; stone fruit production (represented by plum, peach, cherry, and apricot fruit production), production of aggregated fruits (represented by raspberry and blackberry), pseudocarp (strawberry), pome fruits (apples, pears, quince), and grapes. The focus is on different varieties, propagation methods, harvest, post-harvest storage, fungal, bacterial, and viral diseases including the insects causing or transmitting them.

The course "English language in the food industry" (the fourth year of study) offers texts on the methods of food preservation (pasteurization, canning, asepsis, low-temperature storage, drying, smoking, pickling, irradiation, high pressure), preservatives and additives, production of beers and other alcoholic drinks, production of wine, production of cheese, milk and milk products.

To illustrate some benefits of a blended language environment, research was conducted with a focus on biotechnology engineering students' communicative language ability.

Research

The study is focused on the levels of communicative language ability of the biotechnology university students-future biotechnology engineers learning English as a foreign language for specific purposes and potential differences in the levels of students' communicative language ability in two different learning environments - blended language learning and face-to-face language instruction.

Methodology

The participants were 70 undergraduate students (56 females, 14 males) of the Faculty of Agronomy, University of Kragujevac, Serbia.

Students' communicative language ability (CLA) was analyzed considering the theoretical framework (presented in the section on the skills required for biotechnology professionals) where the described competences are regarded as research variables. The studied variables involve:

1) linguistic competence (LC), discourse competence (DC), functional competence (FC), sociolinguistic competence (SLC), strategic competence (SC), fluency (FL), non-verbal communicative ability (NVCA), and general communicative ability (GCA) as the cumulative factor of oral communication focused on general communication efficacy, performed task adequacy, self-correction strategy application, contents abundance, the sophistication of language forms effort of collocutors to understand the speaker;

2) two foreign language learning environments - blended learning and face-to-face (F2F) instruction in pre-pandemic and pandemic eras.

The instrument used in the research was the Communicative language ability scale. It is a complex instrument created to measure communicative language ability as a cumulative factor as well as individual competences (Bojović, 2021). The instrument is based on various measuring solutions created for individual competences by various authors (Bachman, 1990; CEFR; Milanovic, Saville, Poliat, and Cook, 1996). The scale consists of qualitative descriptors indicating the level of each competence measured. It is a Likert-type scale, ranging from 1 to five - the low end indicates a low level and the high end indicates a high level of measured competences.

The procedure involved the following steps: the students simulated participation in a scientific conference in the field of biotechnology with oral presentations which were recorded by a camera; external evaluation of the students' filmed oral presentations was carried out employing the Communicative language ability scale. The obtained data were analyzed using SPSS for Windows. Measures for descriptive and ANOVA statistics were used for data processing.

Results and discussion

The internal consistency reliability analysis showed that the instrument is highly internally consistent and reliable since the reported coefficient Cronbach's Alpha is 0.98. As external evaluation is reported to be reliable since the inter-rater reliability coefficient is 0.81, the obtained results of further analyses are also perceived as reliable.

The results of the descriptive analysis indicate that biotechnology engineering students' general communicative language ability is at a medium level since the mean value is M = 3.26 (Table 1). The levels of respective competences are also at a medium level, the highest being recorded for linguistic competence (M = 3.32) followed by discourse competence (M = 3.30), strategic competence (M = 3.14) and fluency (M = 3.12), and the lowest being recorded for nonverbal communicative ability (M = 2.53). The obtained results imply that the students-prospective engineers in biotechnical sciences are generally capable of communicating appropriately and efficiently, the communication contents being adequate. On the other hand, the corrections made to compensate for language weaknesses are significant and sometimes inappropriate and may demand a certain level of effort to understand a speaker/collocutor. The students' oral skills manifested broad but incomplete knowledge of morphology and syntax

structures, vocabulary is developed at an intermediate level, pronunciation with errors sometimes causing miscommunication, simple cohesive tools are present and usually marked, speech contains details and ideas are sometimes developed in a confused way; language functions are sometimes clear, efficient and proper; the students/speakers are usually aware of the collocutors and context, they sometimes use grammatical but unnatural structures and appropriate cultural references, apply formal register sometimes inadequately. Generally, the students/speakers are capable of communicating main ideas using communication strategies despite the problems present in initiating interaction and reacting to conversation turns; speech is sometimes slow and hesitant, pronunciation is sometimes incorrect, and interferes with communication. However, non-verbal behavior is characterized by often and inappropriate nodding and eye direction; gestures are sometimes used to solve language problems but often inappropriately and unsuccessfully.

Table 1. Levels of communicative language ability in different ESP learning contexts

	ESP courses						
CLA Variables	Possible scores	M	Non-blended pre-pandemic	Blended pre-pandemic	Blended pandemic	F	Sig.
LC	1-5	3.32	3.12	3.33	4.25	13.808	**0.000***
DC	1-5	3.30	3.05	3.35	4.45	24.513	**0.000***
FC	1-5	3.09	2.91	3.12	3.95	12.656	**0.000***
SLC	1-5	2.93	2.78	3.04	3.55	6.712	**0.002***
SC	1-5	3.14	2.97	3.29	3.72	5.87	**0.004***
FL	1-5	3.12	2.98	3.15	3.75	5.993	**0.004***
NVCA	1-5	2.53	2.39	2.67	3.02	2.871	0.064
GCA	1-5	3.26	3.09	3.37	3.95	8.675	**0.000***
N=70, ***p < 0.01**							

ESP - English for specific purposes, N - number of participants, p - statistical significance
CLA - communicative language ability, LC - linguistic competence, DC - discourse competence, FC - functional competence, SLC - sociolinguistic competence, SC - strategic competence, FL - fluency, NVCA - non-verbal communicative ability, GCA - general communicative ability

The results obtained by ANOVA analysis, as shown in Table 1, indicate that statistically significant differences are noticeable regarding the levels of general ability to communicate in English as a foreign language, linguistic competence, discourse competence, functional

competence, sociolinguistic competence, strategic competence, and fluency (for all the variables significance level is $p < 0.01$, the mean difference being significant at 0.05 level). The levels of the measured variables are highest in the context of the blended language learning environment during the pandemic (COVID-19) and the lowest in the F2F language learning instruction (pre-pandemic).

The application of post-hoc test (Dunnett T3) indicates that the most significant differences are recorded between the biotechnology engineering students involved in blended language learning instruction during COVID-19 pandemic and the ones involved in F2F language learning context. The prominent differences are recorded between these two teaching/learning environments considering the levels of most competences measured: linguistic competence ($M = 4.25$ and $M = 3.12$, respectively, $p = 0.003$), discourse competence ($M = 4.45$ and $M = 3.05$, respectively, $p = 0.000$), functional competence ($M = 3.95$ and $M = 2.91$, respectively, $p = 0.000$), sociolinguistic competence ($M = 3.55$ and $M = 2.93$, respectively, $p = 0.006$), fluency ($M = 3.75$ and $M = 3.12$, respectively, $p = 0.007$), strategic competence ($M = 3.72$ and $M = 3.14$, respectively, $p = 0.022$), and general communicative ability ($M = 3.95$ and $M = 3.09$, respectively, $p = 0.002$). There were no statistically significant differences in the levels of non-verbal communicative ability between these two groups ($p = 0.319$, $p > 0.05$).

Also, the same post-hoc analysis showed statistically significant differences between two blended language contexts, pandemic and pre-pandemic, regarding the levels of the following competences: linguistic competence ($M = 4.25$ and $M = 3.33$, respectively, $p = 0.018$), discourse competence ($M = 4.45$ and $M = 3.35$, respectively, $p = 0.001$), and functional competence ($M = 3.95$ and $M = 3.12$, respectively, $p = 0.014$). The statistically significant differences between two blended language instruction and F2F language learning considering the other communicative language abilities were not recorded.

It seems that both learning environments, blended and F2F, facilitated the development of communicative language ability in the biotechnology academic setting. However, it is obvious from the findings that blended language instruction was a more facilitative learning environment. Blended language instruction during the pandemic time (COVID-19) enhanced the students' communication skills in English for biotechnology purposes, including almost all measured competences (the exception is non-verbal communicative ability). The online component of blended learning provides the learners with constantly updated material such as the texts for reading, real-life vocabulary, and audio and video material for developing listening skills which were also used as the starting point for expressing the student's opinion, discussions, and argumentations on the topics with the teacher and peers either in the classroom or via video conferencing tools. In this way, the students are also exposed to foreign language countries related to the English language using the Internet and other ICT (Information and Communication Technology) resources, which is important since students need to learn a language in the context of the culture (Zinan & Sai, 2017, p.72). Some studies report greater general students' satisfaction with blended learning, compared to F2F instruction (Albrecht, 2006, p.6) as well as greater benefits from blended learning (Hitch et al., 2013).

Pains and gains from blending

Keeping the students motivated throughout the whole duration of the course was one of its worrying aspects. The other one was enabling the students to stick to the deadlines for assignments and Moodle submissions. Another worrying aspect was the students' feeling of isolation during the segment of the online teaching/learning.

Among the benefits of blending the students enumerated the following: ease of access to the course materials, an opportunity to receive feedback on their work from their peers in addition to the personalized feedback given by the teacher, and gaining more confidence in their reading, writing, and listening thanks to the opportunity to compare their abilities to that of their peers. Students in the blended learning environment also considered the English reading activities had a more significant influence on their levels of reading comprehension as the online component of blended learning provides the learners with versatile authentic materials making the process of reading in the English language more motivating and valuable. This is also confirmed in a study (Bojović, 2018) examining the undergraduate biotechnology engineering students' perception of the classroom reading activities in blended and F2F language instruction. Another study (Bojović, 2017a) indicates another benefit of blended language instruction: blended language learning was a more facilitative learning environment since the students exposed to such a learning context had higher levels of reading comprehension on both initial and final reading comprehension tests (the upper-intermediate level on the initial and increased on the final test) than their colleagues who were exposed to face-to-face instruction (the low-intermediate level on the initial and the intermediate level on the final reading comprehension test). Also, for students, reading, listening, and writing in the blended learning environment had one additional advantage - it is rich in multimedia which provides learners with more varied stimuli and learning styles.

Lessons learned

While designing the blend and teaching using it, it has become clear that it takes time for students to get used to participating in collaborative work. For students, the online component of the blend in which Video conferencing tools and Moodle were used was a completely new experience both linguistically and technologically; this kind of learning is a new option for students to continue their preparation to compete in the current global world and to have access to diverse and updated information (Flórez, Pineda, & Garcia, 2012). On the other hand, teacher support in blended language instruction is not minimized as the teacher answered the students' messages, graded the exercises, homework, and projects assigned via Moodle, sent feedback to the students, and posted messages in order to promote students' interaction. Therefore, it is highly recommended that EFL/ESP teachers should be well prepared to play the role of constant advisors, promote Web 2.0 tools and answer students' doubts, to decrease students' misconceptions about learning and being able to communicate in English in a blended learning environment.

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