Improving Students' Reading Comprehension Skills through the GOSCIENCE Project's Methods

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Bulletin UASVM Horticulture 76(2) / 2019

Print ISSN 1843-5254, Electronic ISSN 1843-5394

DOI:10.15835/buasvmcn-hort: 2018.0021

Abstract

The article is based on the **GoScience project** funded by the Erasmus+ programme. The project relies on the European context, where in spite of the development of science and technology fewer and fewer students follow a science career let alone one in agricultural sciences. As a result professors of science and their students from seven European countries have joined their efforts to identify innovative practices to motivate students to study and pursue a career in science. The aim of the project is to develop innovative tools for science teaching and learning which will make science education more appealing and empower students to take ownership of their learning. The article studies the main findings of the project's research on methods and techniques used in teaching science and reading comprehension skills applied to scientific texts in foreign languages in Romania. The project's research has identified a common conclusion: an effective reading comprehension instruction would bring about significant changes in students' motivation to study science.

Keywords: agricultural sciences, language learning, reading comprehension, research

Introduction

Despite the advances in science and technologies students' motivation to study or follow science as a career has dropped dramatically in recent years. Universities have repeatedly alerted authorities in the educational field about the decrease in the number of students and the quality of their performance starting with admission; in addition, they have emphasized the need to make substantial changes in the entire educational system. Statistics have revealed that the teaching of science subjects has remained almost unchanged: it still relies on theoretical explanations of scientific concepts and their related phenomena although everybody, teachers and students alike, appreciates experiments and practical aspects

of science and perceives them as a way to better understand theoretical knowledge and as a means for increasing students' interest in complex and hard-to-learn subjects. Changes should start as early as possible in the educational stages as students stockpile growing gaps in knowledge resulting firstly from a lack of comprehension of basic scientific concepts. To this end the project GoScience funded by the Erasmus+ programme develops solid innovative tools for science teaching and learning which are meant to make science education more appealing and empower students to take ownership of their learning by enhancing comprehension through creative instruments commonly used in humanities: storytelling, theatre performances, dances, graphics, or videos.

The innovative feature of the project lies in its endeavour to join European teachers and students' efforts so that they will develop youth culture on gaining comprehension; it also aims at stimulating students' creativity by combining arts and sciences in order to make scientific knowledge better understandable, comprehended and thus with higher probability of implementing it in real life (increased functional literacy for students).

Materials and methods

The research unfolded in two stages. Firstly, it focused on science teaching methodologies used in secondary schools and universities and reviewed the current state of science education across Europe. Secondly, it aimed at mapping students' and teachers' perceptions and opinions of science teaching and learning in these countries. The research was based on a questionnaire and interviews carried out on five university professors, 20 secondary school teachers and 80 secondary school students from several schools in Iasi as well as on the reports and best practices of educational organisations promoted by effective projects and experiences in the field. The questionnaire and interviews collected participants' opinions on science teaching methodology, students' main challenges in studying science subjects and ways of motivating students to learn. The findings do not necessarily provide an exact and complete picture of science education in each of the countries, but show trends and highlight issues and challenges

in the area of science education. The questionnaire and interviews were conducted from March to July 2018.

Results and discussions

The questionnaires were answered by 25 teachers per country (as decided within the partnership and according to the project's application). The questions were elaborated within the partnership according to the needs identified by the research. In the first part of the questionnaire the participants were asked to identify certain limitations of science teaching. The table shows the following results (Tab. 1).

All participants stated that teachers' insufficient training updating teaching methodologies, closely followed by imbalance between theory and practice and lack of solid investment in school equipment and its staff are key factors responsible for the existing state of affairs. They all commented that training is necessary to assure that teachers possess the skills to adapt and excel especially in these changing times. These skills would enable teachers to balance theory and abstract concepts with practical real life issues that students need. Training is meant to boost the overall performance of the organization and the teacher's individual performance. The quality of our education system relies on the quality of each teacher.

The research also focused on students' main problems in learning science (Tab. 2).

Table 1. Certain limitations of science teaching

Certain limitations of science teaching		Number of teachers	%
1	Appropriate teacher training	25	100%
2	Lack of the curriculum to deal with issues that are relevant to students' future (integrate abstract concepts in a real context familiar to students, balance theory and practice, relate classroom learning to reality)	24	100%
3	Adequate status of scientific laboratories in schools	24	96%
4	Effective partnerships with tertiary education providers, business and industry	23	92%
5	The number of the students in the classes	20	80%
6	Appropriate textbooks	15	60%
7	Adequate laboratory equipment (science experiment kits) for demonstrations and experiments	15	60%
8	Inability of teachers to communicate to their students how the skills they teach are utilized in the world of work	10	40%

Table 2. Students' main challenges in learning science (teachers' point of view)

No	Students' main challenges in learning science	Number of teachers	%
1	General knowledge gaps which grow over the years	25	100%
2	Inability to understand/comprehend a scientific text or a scientific explanation	25	100%
3	Inability to understand how academic skills are used in the workplace	24	96%
4	Lack of scientific vocabulary	24	96%
5	Inability to deal with and manage scientific language	24	96%
6	Inability to see the connections of scientific concepts to real-life applications	23	92%

Table 3. Ways of motivating students to study science

No	Ways of motivating students to study science	Number of teachers	%
1	Changes in the school curriculum	25	100%
2	Use of interactive engaging teaching methods	25	100%
3	Integration of technology into the classes	24	96%
4	Emphasis on science practices	25	100%
5	Change in assessment	20	80%
6	Extracurricular activities for students (i.e. scientific summer school, science shows and science communication sessions, science workshops or science clubs, science festivals or science fairs, visits, field trips)	20	80%

All respondents (teachers and students) stated that some students lack the very scientific basics and do not have the necessary skills to comprehend a scientific text. Therefore, they would need more practical input and practice in order to comprehend abstract scientific concepts, which should be related to their previous knowledge and their concrete context. Most teachers complained about students not understanding why they had to study abstract science as they could not see any connection or relevance to their life or future careers.

The findings outline students' lack of comprehension of what they learn, which makes learning superficial and short termed. Some respondents hold that "students learn for a transient grade without integrating what they study into a big picture relating to the world of work and envisaging their future". For lack of time (shortage of classes) introductions to new concepts are not

given the attention they deserve: comprehension is based on students' ability to repeat definitions and rules by heart without developing their critical thinking skills. Many students struggle with comprehension; they understand only fragments of what they read or listen, being unable to grasp and digest the whole process. In time knowledge gaps get larger and larger and students lose their interest mostly due to lack of comprehension.

Considering positive aspects of their teaching, teachers suggested ways of motivating students to study science (Tab. 3).

The suggestions highlighted the role that interactive and humanistic methods have in motivating students to study. Teachers even complained that such methods are insufficiently used for lack of time or bureaucracy ("it is a lot of paper work to take students on a field trip", for instance). Teachers expressed their firm belief that such methods are still effective because

Table 4. Students' challenges in studying science (students' point of view)

No	Students' challenges in studying science	Number of students	%
1	Inability to understand concepts and explanations: what they learn, read or listen is too abstract.	50	62%
2	Irrelevance of what they learn to their reality.	55	68%
3	Problems in managing scientific vocabulary; they do not understand most of the terms although some of them say that they can reproduce their definitions.	59	73%

students are placed in the position of inquirers, not just receptors of facts; students help each other understand an issue (peer learning); learning is based on a real context ("a historical background in a museum shows science as a human endeavour"); students are engaged in interesting and creative open-ended questions, not just guided exercises; students develop attitudes of independence and curiosity; students have a grasp of science as used today in business, engineering, economics, etc; teachers use a variety of assessment techniques: students are not assessed on their ability to reproduce definitions and rules; students understand and appreciate some of the great science ideas that have contributed to our culture and development; students are given new insights into the complexity of science, displaying human aspects such as beauty and creativity.

As for students their opinions on their insufficient connection to science classes refer to teachers' teaching methods, their own inability to connect what they learn in the classroom to the world of work and their future as well as their lack of understanding what they learn in the classroom: (Tab. 4).

Most students stated that they had problems in comprehending scientific texts; they also complained about the teaching methods: "they are too rooted in theoretical explanations without concrete experiments to highlight why they have to study those issues: for their applicability and usefulness in the real world". In addition, they held that "there is no variety of methods: long lectures difficult to follow and understand even if they are based on PPTs".

The findings showed that teachers and students shared a lot of opinions in common. The suggestions which would provide solutions exploited the values of humanistic ways in

motivating students based on communication, team work, project work and love/satisfaction of learning as well as the integration of ICT into the classroom.

The project's research has evaluated the findings and decided that an effective comprehension instruction would bring about significant changes in students' motivation to study science. The output is a guide for teachers, which helps them to enhance students' comprehension and literacy in the context of science learning (vocabulary in science education, reading and listening comprehension in science education, the use of visual analogies, arts and ICT).

The guide stems from important points identified in teachers' questionnaires and best practices focusing on developing and improving students' reading and listening comprehension of scientific texts (Croner, 2003; The RAND Reading Study Group, 2005; Pressley, 2005; Moore, 2005; Reutzel and Cooter, 2011; Heidingers *et al.*, 2012, Brown, 2015; Adler, 2016).

To this end, the guide attempts at updating science teachers with main principles which should underpin reading and listening comprehension instruction in science (Moore, 2005; Nadig, 2013; Johnson, 2015), important factors contributing to reading and listening comprehension development (Rosas, 2003; Pressley, 2005), comprehension strategies (Croner, 2003; Carbo, 2007; Ronan, 2015; Reutzel, 2011; Adler, 2018; Lewis, 2018), teaching techniques (Gould Boardman *et al.*, 2008; Reutzel and Cooter, 2011; Brown, 2015; Johnson, 2015, Gaidule *et al.*, 2015, Feland, *et al.*, 2016; Graham and Brouillette, 2016; Green *et al.*, 2017).

Teachers are also encouraged to integrate tools and practices using technology in their classes in order to enhance reading comprehension. Technology encourages teachers' flexibility

regarding the selection of the text. Technology is effective when it is integrated into the curriculum and becomes routine in classrooms.

The guide also aims at helping teachers to cope with reading difficulties. Students' reading difficulties may be brought about by poor comprehension (the understanding and interpretation of what is read). In order to be able to understand a text, students need to be able to (1) decode what they read; (2) make connections between what they read and what they already know; and (3) reflect on what they have read (Pardo, 2004). Vocabulary, fluency and comprehension are more common with older students. Vocabulary plays a vital role in the reading process: readers cannot understand a text if they do not know what most of the words mean. Therefore teachers should focus on helping students enrich their vocabulary by: discussing the meaning of words as they go through the text; teaching note-taking skills and summarizing strategies; using graphic organizers that help students break information down and keep track of what they read; encouraging students to use and revisit targeted vocabulary words; teaching students to monitor their own understanding; teaching students' comprehension monitoring strategies; teaching students how to make predictions and how to summarize; teaching specific "fix-up" strategies to repair misunderstanding, such as re-reading, re-stating, and using context and decoding skills to figure out unknown words or ideas; teaching students how to use graphic and semantic organizers.

The guide highlights the role that projects and best practices play in enhancing the teaching/learning processes. For instance, research has shown that students who read about the scientists' intellectual or personal lives are more likely to think of famous scientists as people, like themselves, who had to overcome obstacles and failure to succeed. Students who did not read about scientists' lives often believe that great scientists had a special aptitude for science that separated them from everyone else. Scientists' lives are great examples to follow.

The best practice offered by European projects should also be taken into account: for instance, the ADORE-Project "Teaching Adolescent Struggling Readers. A Comparative Study of Good Practices in European Countries" aimed at pointing out principles and key elements of good practice,

identifying criteria for assessing the quality of these practices and building a network of researchers and practitioners in the field of adolescent literacy across European countries. The ELINET project aimed at building a strong network that brought together European policy actors committed to reducing the number of children, young people and adults with poor literacy skills in Europe.

The Goerudio project aimed at meeting two challenges facing European schools: secondary and vocational school students' lack of motivation when studying scientific related topics; school teachers' lack of innovative teaching methods to promote students' interest in scientific issues. The project's products enable students to go through visual and audio creative experiences, which are rooted in daily reality, make science accessible and stir interest in studying science. The Enature project promotes a proactive students' approach to scientific subjects learning and proposes innovative teaching methodologies to scientific teachers. Problem-based and real life cases underpinning the project's outputs enable students to improve their basic skills and get involved in the learning process.

The feedback on the guide received from teachers and students consolidated our findings, especially those related to our solutions to the identified problems. Everybody agreed that an effective comprehension instruction and literacy in the context of science learning would bring about the expected changes in students' motivation to study science. Some of them even stated that similar strategies should be applied to foreign languages classes where students get familiar with scientific texts in their field. Teachers (90%) also expressed that their training is very important in stimulating students' motivation, which was also reflected in students' firm belief that their teachers' methods impact their learning. Another common suggestion was the use of modern technology with a view to enhancing reading comprehension. Technology may provide teachers with useful tools, which appeal to students.

At the next stage in the development of the project the partnership will identify 100 main scientific concepts in physics, mathematics, biology and chemistry, which are most frequently misunderstood by students. Each concept will be defined and explained and illustrated through arts, drama, stories or analogies. The final products will

be filmed and uploaded on the project's site so that all teachers can use them.

Given the international context characterised by student mobility and internalisation of higher education reading authentic materials is very important nowadays. Students face demanding tasks of learning subject-matter through English or other languages. In order to study students need to develop proficiency in reading several languages. The connections between reading skills in mother tongue (L1) and other language (L2) are not too clear but it is known that better literacy in the mother tongue helps developing literacy skills in L1 and adequate knowledge of the foreign language (Kavaliauskiene, 2010). On the other hand, foreign language learning can support L1 development. Vygotsky (1962) wrote the following: "... a foreign language facilitates mastering the highest forms of the native tongue. The child learns to see his language as one particular system among many ... and this leads to awareness of his linguistic operations". Analyses of the verbal reports have revealed that thinking processes are common to reading in L1 and L2 but also depend on people's literate expertise and relevant knowledge (Cummins, 1984). However, further research is needed to explore every aspect of this potential.

Reading materials in another language poses serious difficulty to students but there is a wide range of ways of addressing the problem of language difficulty. Before reading a text in L2 students need to be taught difficult or unfamiliar lexis; encouraging them to read extensively, training them in intensive reading and familiarising them with reading strategies (skimming and scanning) are first stages for developing reading skills in both languages. To develop an independent reader, teachers use more or less similar strategies in L1 and L2: summarizing, comparing, analysing controversial issues, inferring, connecting information from different parts of the text or evaluating. These strategies are supported by deducing the meaning of unfamiliar words and word groups (more in L2) as well as implications, i.e. conceptual meaning, less explicitly stated information, distinguishing facts from opinions etc.

The findings of the research were applied to 30 students of medicine and oenology during their foreign language courses (school year 2017/2018). The teachers were invited to teach their students specific reading strategies and ask them to use these strategies while reading scientific texts. The students were given plenty of opportunities to work on scientific texts, practise

Table 5. Stages of the session: reading activities

No	Stages of the session	What students do
1	Pre-reading activities	Raising interest <i>Have you ever been to a wine tasting? Can you share your experience with your peers?</i> Pre-teaching vocabulary (based on students' previous knowledge and experience) <i>What words do you associate with wine tasting?</i> <i>What do you know about the topic?/ What would you like to know about it?</i>
2	While reading activities Think, pair, share strategy: students do these activities individually, in silence); then they pair review them and finally they check them with the whole class.	Set gist questions <i>What are the main ideas of each paragraph?</i> Set detailed questions <i>Match terms with their definitions</i> <i>Read the text and tick the sentences which are false.</i> <i>Ask clarifying questions about the text.</i> <i>What unknown words did you come across while studying this text?</i> <i>What did you learn about the topic?</i> <i>What else would you like to know about the topic?</i>
3	Follow-up activities	Ask students to work in pairs to complete a search on the history of wine tasting within a specific time frame.

reading strategies and carry out activities meant to stimulate their comprehension.

The following scientific text was one of the texts which helped teachers improve their students' comprehension and reading skills:

The organoleptic analysis of wine is commonly known as wine-tasting and uses the human biological senses: sight, hearing, smell, taste and touch, determining thus the olfactive, retro-olfactive and taste characteristics in order to create an aroma profile (usually a pie-chart representation).

14 olfactive and retro-olfactive parameters were used, with 8 taste characteristics. Some of the aroma indices that were used are: citric, vegetal, exotic fruits, ripe fruits, freshly cut grass, coffee, caramel, leather, mushrooms, spices, mineral sensations. Each of these characteristics was evaluated by a panel of tasters and graded from 0 to 9, 0 being the absence of the parameter and 9 being an overpowering sensation of the same characteristic.

The taste evaluation took into account indices such as: sweetness (or dryness), bitter, acidity (tartness or zestiness), salty, phenolic, onctuousness, astringency. The structure of wines has also been evaluated by registering the body of the wines, its texture and balance.

The students had to go through the following activities, based on the text (Tab. 5).

As stated by the students themselves, the experiment enabled them to get familiar with and practise effective reading strategies, enrich their vocabulary, evaluate their reading skills, develop their reading comprehension skills, develop their critical thinking skills, develop their research skills, get interested in reading the text and connect the text to their experience and knowledge.

The research revealed interesting facts about reading scientific texts in one's mother tongue and in a foreign language. Some students (23%) from university stated that reading a scientific text in another language raised their awareness about the reading strategies they could use when reading scientific text in any language and, as a result, they found themselves more focused when reading scientific texts in Romanian (L1). Most students (65%) said that basic vocabulary is similar in the languages they spoke and they noticed that learning vocabulary in another language consolidated the vocabulary in their mother tongue. All of them agreed that going through scientific texts in several

languages provided them with practice not only in vocabulary but also in reading strategies.

The teachers were asked to identify the challenges their students met when first reading the scientific text. To begin with, they held that a few of their students found it difficult to construct meaning from the scientific text because they were not familiar with some basic scientific concepts, which meant that they actually they did not understand what they were reading about. Those students did not understand specialized vocabulary terms and phrases that are unique to science. The activities helped students solve their vocabulary and comprehension problems. A dictionary of terms accompanying the textbooks would help students find their way in the books.

Secondly, most students lacked important reading skills, which could help them make sense of new information in light of what they already knew. Teachers found the experiment as an invaluable opportunity to teach and have students practise reading strategies.

Finally, the teachers noticed that some students had a poor attitude toward reading and often did not see the connection between the effort they put into reading and completing their tasks and the grades they got in class. After the pilot the teachers were of the opinion that they should also carry out activities teaching students strategies to select when they do not understand what they are reading (Fix-Ups). The following fix-up strategies were suggested when students experienced comprehension failure: ignore the problem and continue reading, make a hypothesis, using the information from the text, and continue reading, reread the previous sentence, stop and think about the previously read context; reread if necessary and seek help (materials, teachers, peers).

Conclusions

Without reading comprehension, reading loses its very purpose: to help students learn and acquire knowledge. In addition to acquiring knowledge, oral and written language skills continue to develop with exposure to new ideas and vocabulary in printed text.

Having excellent reading comprehension skills is vital. Reading comprehension skills enhance the pleasure of reading and make reading effective. They ensure students' well-rounded development

in a variety of aspects: intellectually, socially, and professionally. Effective reading comprehension skills help students with all school subjects.

Moreover, the tests that evaluate students' progress in school and are used to determine their admission to colleges and universities are mainly based on reading comprehension skills. Therefore, developing students' effective reading comprehension skills must be at the centre of any educational policy.

The study had its limitations related to the small number of participants (students and teachers) and the short time covered by the experiment (limited by the project's application). The results show that reading comprehension instruction can offer positive learning experiences in schools. Teachers' training courses in reading strategies to be implemented in class in their teaching/learning process would probably improve the existing situation.

The project's implementation has not been completed yet and probably new comments from participants will provide us with fresh insights into this matter.

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