Cross-curricular strategy to increase eleventh graders' involvement in chemistry lessons at "Instituto Técnico Agrícola Rafael Ortiz González"

Estrategia curricular para aumentar la participación de estudiantes de undécimo grado en las clases de química en el "Instituto Técnico Agrícola Rafael Ortiz González"

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Palabras clave

Bioquímica, Inglés como lengua extranjera, estrategia transversal, enfoque CLIL (Content and Language Integrated Learning).

Resumen

Este artículo presenta el diseño e implementación de una estrategia transversal en un colegio público de Colombia aplicando el enfoque CLIL. Los participantes fueron doce estudiantes de undécimo grado del "Instituto Técnico Agrícola Rafael Ortiz González" y su profesor de química. Los participantes acordaron contribuir con este trabajo para mejorar sus estrategias metodológicas y desempeños en el área. Se adoptó el enfoque CLIL porque favorece el uso de contenidos auténticos y técnicas de enseñanza que hacen a los aprendices interactuar significativamente con la información nueva, como una forma de apoyarlos en la construcción de conocimiento. El idioma inglés sirvió como vehículo para llevar mensajes relacionados tanto con las interacciones en el aula de clase, como con la comprensión y producción de discurso científico. La implementación de la estrategia tomó 18 horas. Con el fin de promover exitosamente los elementos de Contenido, Cognición, Cultura y Comunicación, las actividades incluyeron materiales auténticos, variedad de ejercicios para cada etapa de las clases, un enfoque fuerte en la conservación de la salud y una cantidad considerable de oportunidades de interacción social. En la implementación de las clases, la participación de los estudiantes fue notable, y su profesor tuvo un papel sobresaliente como fuente discursiva en inglés.

Keywords
Biochemistry, foreign language (L2), cross-curricular strategy, CLIL approach.

Abstract
This article presents the design and implementation of a cross-curricular strategy at a state school in Colombia through the application of the Content and Language Integrated Learning (CLIL) approach. The participants were 12 eleventh-grade students at "Instituto Técnico Agrícola Rafael Ortiz González" and their Chemistry teacher. The decision of using CLIL approach relies on the provision of authentic input and teaching techniques that make learners interact meaningfully with new information, as a means of assisting them in the construction of knowledge. The English language was used as a vehicle for conveying messages that related to both, the usual interactions in the classroom and, comprehension and production of scientific discourse. The implementation of the strategy took 18 hours. In order to successfully promote the issues of Content, Cognition, Culture and Communication, the activities included authentic material, variety of exercises for the different stages of the lessons, a strong focus on health preservation and a considerable amount of opportunities for social interaction. Throughout the implementation of the lessons, students' engagement in all the activities was noticeable and their Chemistry teacher played an outstanding role as a source of listening.

Introduction

The policies of bilingualism, described by the National Ministry of Education in Colombia (MEN) a decade ago, placed on schools the demands of creating and implementing effective English language programs (MEN 2006). Notwithstanding, most state schools have lagged behind in the fulfilment of this task. In the case of the school community at "InstitutoTécnicoAgrícola Rafael Ortiz Gonzalez", a first step has been taken in order to carry out such an important transformation. Eleventh graders, together with their Chemistry and English teachers decided to take part in the design and implementation of a cross-curricular strategy based on the CLIL approach to foster their engagement in lessons, enrich them with varied teaching techniques and improve their performance in the subject competences.

Embracing the CLIL approach allowed teachers to use English for teaching Chemistry while promoting content, cognition, culture and communication in the classroom. The activities planned for each lesson reflected the above mentioned principles. In addition, all the elements that play a role in each of the principles shed light on how to motivate learners to both learn Chemistry and English, and make pupils feel as important members of their community.

The principles of Content and Language Integrated Learning (CLIL)

As previously mentioned, CLIL was the approach used to design the strategy. Following there is a description of methodological implications of CLIL, organized according to Coyle's 4Cs (1999), as well as the relationships that each aspect of CLIL holds with other learning theories.

Table 1. *CLIL principles and links to other learning theories. The principles announced in this chart served as guidelines for the design of the cross curricular strategy.*

	Content	Cognition	Culture	Communication
Methodological Implications	▪ Exposure to authentic materials. ▪ Adapting materials to fit students' needs concerning vocabulary, grammar.	▪ Development of thinking skills. ▪ Activation of schemata. ▪ Devoting time to analyse new content and ways to interact with it.	▪ Reflection on ▪ how new knowledge affects learners' roles in their community. ▪ Use of adequate materials, intercurricular links (Byram 2008) ▪ Health preservation, key aspect for the teaching of Science in Colombia (MEN, National Standards for Science)	▪ Providing social interaction. ▪ Setting patterns of interaction. ▪ Assisting learners in the development of productive skills. ▪ Negotiating meanings. ▪ Giving clear instructions. ▪ Defining the nature of language: of / for /through learning?

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Relationship to other learning theories	▪ Krashen's comprehensible input hypothesis (Richards and Rodgers 1999).	▪ Bloom's taxonomy. Higher-Order Thinking skills (HOTS) and Lower-order thinking skills (Krathwohl). ▪ Cummins: levels of task difficulty (1984). ▪ Howard Gardner's multiple intelligences theory (1983)	▪ Tye, 1990 as qtd in. Levy. "Global education, helps children recognize the interconnectedness of the world through a study of the problems and issues that cut across national boundaries"	▪ Vigotsky: Knowledge as a social construct (Van Der Stuyf 2002)

Source: Author

Description of the Strategy

Population, considerations and stages

The target population of the strategy were eleventh graders whose English level of proficiency is A1 according to SABER test results in the last two years. Their Chemistry teacher has a B1 level of English, also according to a SABER test. They had 3 hours of Chemistry per week. The course took 18 hours. During the implementation of most lessons, the designer of the strategy accompanied the participants, pointed out some observations and gave feedback to the teacher after those lessons. Topics for the last term of the academic year related to Biochemistry. For that reason, the themes were: levels of the food pyramid, carbohydrates, proteins, vitamins, hormones and drugs. The process of designing the activities for each lesson had some important considerations, as it is described below.

Content selection and grading

The Biochemistry books offered very detailed and long explanations for each theme. It was the designer's task to gather the information and adapt it to the students' cognitive demands for the starter level. In the reading texts, some ideas were rephrased, unnecessary information was deleted and pictures related to the topics were added. The structure of the texts was also reorganized in most cases in order to make the hierarchy of concepts clear enough for learners. The material used entailed science videos, webinars, power point presentations, science reading texts, articles and news.

In addition to that, every listening, reading, writing and speaking activity involved three stages: pre-, while and post. The pre- or warm-up stage had the purpose of activating students' previous knowledge and encouraging them to learn the new contents. In the while stage students did exercises that allowed them to interact and get a better comprehension of the topics. In the post- stage, students were engaged in exercises that checked their comprehension and enabled them to produce both written and oral output. By emphasizing selection and grading, our participants' learning process could occur at an adequate pace.

For a better understanding of what the abovementioned claims implied for the design and implementation of the strategy, here is an extract from the lesson plan for the first class. See table 2.

Table 2. *Plan for lesson 1, week 1.*

Pre-	As a warm-up, students respond three questions about their food habits. With the answers, they make snowballs and throw them to one side of the classroom. After that, the teacher picks some snowballs and discusses the answers. For the second part of the warm-up, students are asked to work in groups of three to solve a puzzle with a picture of a food pyramid. The winners get some extra points. Then, the teacher projects a slide with the food pyramid and elicits from students the names of the foods that appear in the picture. The teacher focuses on the servings that people must eat every day.
While	In the lead-in part, students work in pairs and read carefully a short article about vitamins, proteins, minerals, fiber and carbohydrates. The teacher talks to each couple and negotiates meanings to help them understand the function of each kind of nutrient. Next, a second slide appears on the board. Students are told to match the names of nutrients to the parts of the body they benefit.
Post-	For the production part, the teacher gives the students a handout that contains some connectors of addition and contrast. Students work individually, they circle the appropriate connector and rewrite sentences about the similarities and differences among the different nutrients.

Source: Author

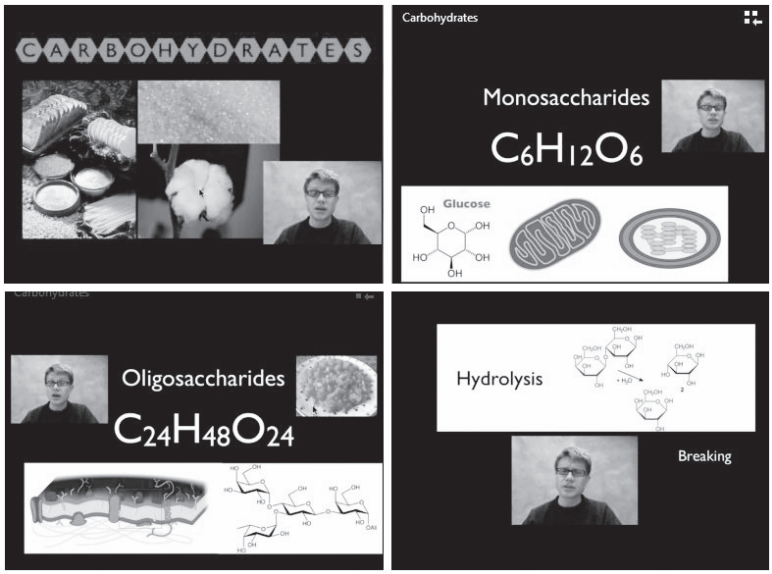
Cognitive development

One of the most significant aspects of CLIL is the concern about thinking process development and content retention. It was vital for the designers to plan carefully the warm-up activities to introduce specialized vocabulary and concepts of the different topics. Examples of these activities included: LOTS questions (what, where, when), HOTS questions (why and how), picture puzzles, KWL charts, cryptograms, dominoes (see picture 1), questions race, experiment, demonstrations, spidergrams, and matching exercises, among others. For the lead-in and assessment stages of the lessons, activities such as filling-in gaps exercises (See picture 2 and appendix 1), checklists, multiple choice questions, mind map creation, HOTS and LOTS questions, word puzzles, mazes, bingo, slide presentations, oral presentations, hot potato and board games (see picture 3 and appendix 2) were used.

Picture 1. *Vitamins domino, game used in the sixth week of implementation. The picture was taken during the lesson.*

Source: Author

Picture 2.*Video by Paul Anderson*



Source: http://www.youtube.com/watch?v=_zm_DyD6FJ0

Picture 3. *Eleventh graders playing a board game to check their understanding of the concepts.*

Source: Author

Board games are an excellent way to assess students' understanding of concepts and enhancing speaking skills.

Fostering culture

The aim of enclosing culture in lessons is to build up tolerance towards others. The issues concerned with Biochemistry give teachers the chance to raise awareness about nutrition and health preservation, something that affects us all. By identifying and putting into practice healthy habits, learners will play a better role as members of this world community. In the activities designed to address each of the topics, the aspect of health impact was always present. Along the weeks, lessons reflected this concern. See the table below.

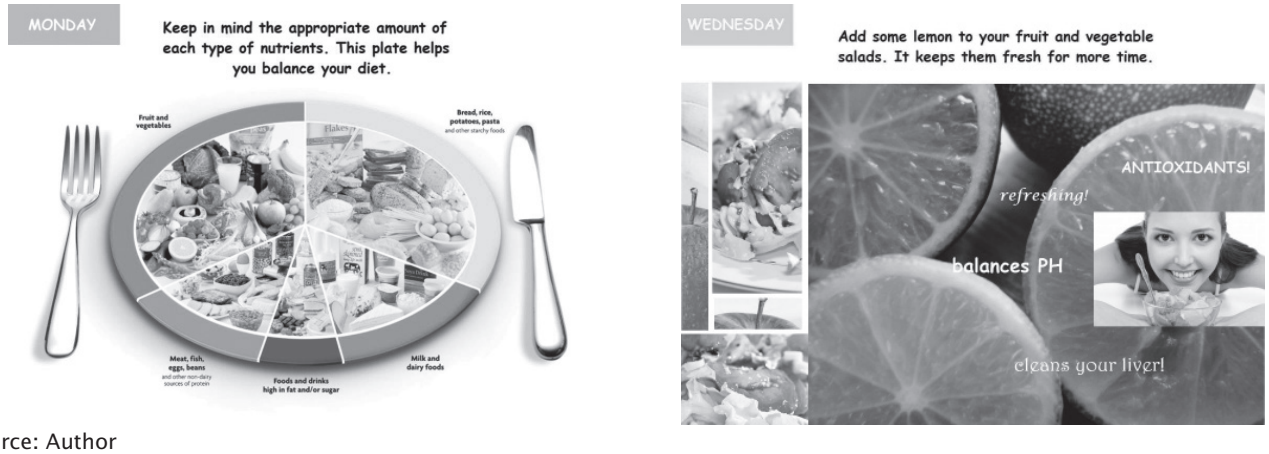
Table 3. *Activities in the strategy that foster the aspect of Culture. All the activities were designed by the authors for the specific purposes of each exercise.*

	Name of the activity	Activity objective
Week 1	Food pyramid Reading texts	Recognize the importance of different nutrients for our body.
Week 2	Survey: A healthy lifestyle	Raise awareness about the importance of physical activity for our health.
Week 3	Reading: How carbohydrate metabolism affects weight.	Promote awareness about the impact of carbohydrates in people's weight.
Week 4	Word puzzle: sources of protein	Identify vegetal and animal sources of protein.
Week 6	Vitamins domino Vitamins maze Tip reading: a five-day advisor for a healthy life.	Encourage comprehension of vitamin functions and good nutrition habits.
Week 7	Demonstration: Making a healthy salad	Show students alternatives for a healthy menu.
Week 8	Reading: : Hormones in food	Inform learners about the uses of biochemistry in food engineering.

Source: Author

This aspect was included by means of reading and listening texts (see picture 4) that provided new information, comprehension questions and group discussions through board games, hot potato, or tingo-tango exercises. Below there is a description of one of these exercises.

Picture 4. *Reading tips: A five-day advisor for a healthy life, tips for Monday and Wednesday (teacher-made cards)*



Source: Author

Once the students and the teacher have reflected upon the results of the experiment, the teacher asks them to look for some tips under their desks. The tips are part of a five-day advisor for a healthy life. Some volunteers read the tips and think about their meanings for 5 minutes. Next, they discuss about how suitable the tips are for their daily life. Then, the teacher collects the tips and puts them into the five-day advisor box. The student who says a right number wins the collection of tips (Neira, 2013)

Eleventh graders were also part of some oral presentations; during the seventh week, students did a follow-up activity that consisted of making a video while preparing a healthy salad (See picture 5). In the previous lesson, their teacher had made a demonstration to show them how to carry out the task.

Picture 5. *Images taken from student-made videos: How to make a healthy salad*

Source: Author

Enhancing communication skills

There were two vital aspects to work on regarding this issue. Those were: usual communication in the classroom and production of science discourse. The first one takes place when a student needs to ask the teacher for help or negotiate meaning of key concepts. In this case, at the beginning of each lesson the teacher introduced some useful phrases to convey students' needs. During the lesson, he encouraged eleventh graders to use those statements as a way to get his support. For the discourse production, the guidelines and assessment criteria were described in the learners' handout or during power point presentations. Students were asked to write answers to their pieces of homework using L2, make a mind map about one of the topics, and write instructions for a healthy recipe. For the speaking part, a survey was conducted among students. Students also participated in the discussion of the answers for each topic, discussed with their peers about the characteristics of nutrients, played board games to assess their learning process and recorded two videos: one of them to present their mind maps about proteins, and the other to demonstrate how to make a healthy salad. For the sake of supporting pronunciation and intonation, their English teacher planned some tutoring hours in the afternoon. During their Biochemistry course, the eleventh graders could practice monologues and dialogues in a balanced way.

Three observations were carried out for the description of the implementation part. They took place during three two-hour lessons. There, the designer of the strategy played the role of a student; she engaged in all the activities and made notes about the teacher's performance. The idea was to gather evidence about how the teacher's way to deliver the lesson actually supported CLIL claims. This exercise allowed the designer to empower the chemistry teacher with suitable teaching techniques. Six points were part of the observations: preparation, language use, lesson presentation, classroom management, classroom atmosphere and use of technology.

To begin with, *preparation* and *language use* refer to the organization of the activities in the lesson and the use of L2 and specialized discourse. Those were two of the strongest points in the chemistry teacher's performance. The use of L2 was predominant in the lessons; he only spoke in Spanish when it was absolutely necessary. When introducing topics, he used the specialized vocabulary properly and made sure that eleventh graders understood what those words related to. Examples and rephrasing were very useful tools.

The item *lesson presentation* deals with the coherence existing between learning outcomes and activities, time use and balance of teacher and students' discourse. During the first week, eleventh graders participated only when they were asked. From the second week on, they started giving answers voluntarily in the discussions. In the last weeks, they were more interested in learning phrases to express themselves. That was noticeable when they had the speaking tasks; they showed a genuine interest in making high quality pieces of speech. Their Chemistry teacher always insisted on using the phrases he had introduced at the beginning of the classes. About time use, for the productive abilities it was necessary to include tutoring hours (with the English teacher), for the sake of improving pronunciation and intonation.

Talking about the missing aspects of the observations, it can be said that both eleventh graders and their Chemistry teacher felt comfortable, there was a respectful environment and students accomplished most of the goals set in their Biochemistry course. Technology was also taken into account; there were webinars, power point presentations, video projections and video recordings.

Finally, when dealing with the stages of this process, there were two main phases: the design of the strategy and the implementation. The table below shows the main activities involved in these phases and the time it took for the designer to carry them out. Some of the activities were done simultaneously, as they sometimes implied modifications due to the participants' needs.

Table 4. Steps followed during the development of the cross curricular strategy.

PHASE I Strategy Design	Literature review	2 weeks
	Selection of participants	3 days
	Selection of contents and materials	1 week
	Adaptation of materials to the students' level	2 weeks
PHASE II Strategy Implementation	Implementation of the strategy	6 weeks
	Lesson observations	3 sessions
	Reflections about the experience (both students and teachers)	1 week

Source: Author

Conclusions

Since the participants of this study had a starter level of English, determining levels of difficulty for the activities was a vital part of the cross curricular strategy. It enabled teachers to provide scaffolding instruction, which is the "role of teachers and others in supporting the learner's development and providing support structures to get to that next stage or level" (Van Der Stuyf 2002).

All the lessons had an adequate sequence with smooth transitions and moderately challenging exercises to explore the diverse items of the course. These features could be observed in the pre-, while and post- exercises that were designed to address both productive and receptive skills.

There were only time constraints when facing speaking tasks. They demanded some extra tutoring hours for individual pronunciation and intonation matters. For the sake of improving those issues, the teacher also recorded utterances in the students' cell phones. Once eleventh graders had prepared their pieces of speech, they were asked to read and record their voices. After that, the teacher gave them feedback in the tutoring hours.

In order to get students successfully involved in lessons, the warm-up activities involved relevance, creativity and authenticity. This is a point that Krashen addressed in his Comprehensible input Hypothesis. Students must be exposed to authentic language use and given enough tools to comprehend it. That is the first step for language acquisition.

Eleventh graders from "InstitutoTécnicoAgrícola Rafael Ortiz González" derived multiple benefits from this cross curricular strategy based on CLIL principles. They did a biochemistry course that guided them to understand the importance of eating properly, enhanced social interaction and challenged them to do a variety of exercises to develop cognition and acquire concepts.

The cross-curricular strategy also increased learners' opportunities to practice monologues and dialogues as demanded by the National Standards of English in Colombia (2006); which were based on the Common European Framework of Reference.

In the case of the Chemistry teacher, his teaching techniques were enriched by an approach that is concerned with gaining a deep understanding of Biochemistry elements, raising awareness about its application in the dairy industry and fostering students' interest in the subject.

The inclusion of exercises such as sudokus, cryptograms, puzzles and game boards, among others, allowed eleventh graders to work on the development of multiple intelligences as called for in Gardner's theory (Gardner et al, 2012).

To carry out this strategy, learners counted on a Chemistry teacher who is a proficient speaker of English and agreed to be part of the implementation, facing all the demands that CLIL places on educators. During all the process he showed a reflective attitude that contributed to do a better job lesson by lesson.

Further work is called for in order to efficiently address bilingualism policies in Colombian state schools. Promoting the design and implementation of cross curricular strategies is an issue that Principals, teachers (from all areas of knowledge) and students must be committed to. It demands getting qualifications for being proficient English speakers, having a flexible attitude and sufficient time to adapt materials and put into practice CLIL principles.

References

Bourne, J. and Moore, J. (2005).*Elements of Quality Online Education: Engaging indeCommunities.* Retrieved from http://books.google.com.co/books?id=GgCPAgAAQBAJ&pg=PA276&lpg=PA276&dq=Bourne,+J.+and+Moore+J.+(2005).+Elements+of+Quality+Online+Education&source=bl&ots=A8VZCIJ3t4&sig=H_6b3StxsfDUIeZE4GXh9ppCI6M&hl=es&sa=X&ei=8vEqVID7IdGSgwTa2oLoDw&ved=0CD0Q6AEwAw#v=onepage&q=Bourne%2C%20J.%20and%20Moore%20J.%20(2005).%20Elements%20of%20Quality%20Online%20Education&f=false

Baker,J. *Lesson plan:Working Collaboratively in the College EFL Classroom.* Retrieved from:http://esl.about.com/library/lessons/bl_baker2.htm

Cambridge University Press. The CLIL toolkit: Transforming theory into practice. Cambridge. Retrieved from http://www.cambridge.org/servlet/file/9780521112987c04_p4873.pdf?ITEM_ENT_ID=5633692&COLLSPEC_ENT_ID=7

Coyle, D. (1999). Theory and planning for effective classrooms: supporting students in content and language integrated learning contexts.In Masih, J. (ed.) *Learning through a foreign language.* London: CILT. Retrieved from: http://books.google.com.co/books?id=c_a6daEzpkkC&pg=PA15&lpg=PA15&dq=Theory+and+planning+for+effective+classrooms:+supporting+students+in+content+and+language+integrated+learning+contexts+in+Masih,+J.+(ed.)+Learning+through+a+foreign+language.+London:+CILT.&source=bl&ots=n1xv0eFlui&sig=Z9mkQCJtk1cFZ4h72_HKisLZnmk&hl=es&sa=X&ei=eQ0rVJiGBOvCsATo64GYCw&ved=0CDoQ6AEwBA#v=onepage&q=Theory%20and%20planning%20for%20effective%20classrooms%3A%20supporting%20students%20in%20content%20and%20language%20integrated%20learning%20contexts%20in%20Masih%2C%20J.%20(ed.)%20Learning%20through%20a%20foreign%20language.%20London%3A%20CILT.&f=false

Gardner, H., Davis, K., Christodoulou, J. andSeider, S (2012). *The Theory of Multiple Intelligences.* Retrieved from http://howardgardner01.files.wordpress.com/2012/06/443-davis-christodoulou-seider-mi-article.pdf

Krathwohl, D. (2002) *A revision of Bloom Taxonomy: An overview. Wilson web.* Retrieved fromhttp://rt3region7.ncdpi.wikispaces.net/file/view/8+Perspectives+on+RBT.pdf

Levy, A. (2013). *Culture in the Classroom.* Retrieved from http://www.earlychildhoodnews.com/earlychildhood/article_view.aspx?ArticleID=141

Ministerio de Educación Nacional de Colombia. (2006). *Visión 2019: Educación propuesta para discusión. (1ed.)*. Bogotá: Autor.

Ministerio de Educación Nacional de Colombia. (2006). *Estándares básicos de competencias en Ciencias Naturales. (1ed.).* Bogotá: Autor.

Ministerio de Educación Nacional de Colombia. (2006). *Estándares básicos de competencias en lenguas extranjeras: Inglés. (1ed.).* Bogotá: Autor.

Richards, J. and Rodgers, T. (1999). *Approaches and methods in language teaching.(15th ed.).* Cambridge: Cambridge University Press.

Van Der Stuyf, R. R. (2002). Scaffolding as a teaching strategy.Adolescent learning and development, 2-13. Retrieved from: http://www.sandi.net/cms/lib/CA01001235/Centricity/Domain/18944/Response%20to%20Intervention/scaffolding_as_a_teaching_strategy.pdf

Appendix 1. *Teacher-made worksheet*

INSTITUTO TÉCNICO AGRÍCOLA "RAFAEL ORTIZ GONZÁLEZ
BIO-CHEMISTRY COURSE / ELEVENTH GRADERS

NAME: DATE:

1) Think about the title and fill in the first two columns of the chart:

ALL ABOUT CARBOHYDRATES

What I know	What I want to know	What I learned

2) Watch this video by Bozeman Science and tick (✓) the types of carbohydrates.

1) ___ Nucleic acids
2) ___ Monosaccharides
3) ___ Lactose
4) ___ Oligosaccharides
5) ___ Sucrose
6) ___ Disaccharides
7) ___ Glucose
8) ___ Glycogen
9) ___ Fructose
10) ___ Polysaccharides

3) Watch the video again and complete the statements. Use words from the box.

fructose	dehydration hydrolysis	structure glucose	cellulose

a. Carbohydrates provide us with energy and _____.
b. Glycogen and _____ are examples of polysaccharides.
c. The process by which our body breaks sugars into smaller molecules is _____.
d. The simplest sugar molecule is called _____.
e. Sucrose is a combination of glucose and _____.
f. The process of losing a molecule of water to make a carbohydrate simpler is called _____.

4. Go back to exercise 1 and fill in the third column.

Source: Author

Appendix 2: *Board game used during the seventh week of implementation.*

Source: www.mesenglish.com. Adapted by author.