Chapter 4

Concept Formation for Enhancing Students' Analytical, Creative, and Critical Thinking Skills

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INTRODUCTION

The Industrial Revolution 4.0 has resulted in the necessity to develop and implement new practices in all education cycles. It both poses the opportunities and challenges at both individual level and the society at large. Therefore, the emerging issues are related to the necessity to adjust to this new situation, which is one of the objectives for the educators, namely, equipping the teachers and students with the knowledge, skills, and attitudes relevant to successfully functioning under new circumstances. "The 21st century university student will not experience the kind of classroom that her instructors did" (Yacobucci 2012: x). The transversal skills – problem-solving, critical and creative, communication skills, analytical thinking, etc. – these are just some of the skills to be acquired within the study process. The "static body of knowledge" does not work anymore (Ibid.). Therefore, "a larger percentage of the course devoted to providing students with opportunities to work with concepts, practise skills, and develop their own understanding of course material" should be developed (Ibid.). Apparently enough, also the study environment will have to be transformed into the collaborative platforms being student-centered and promoting cooperation skills at the same time. Furthermore, it is obvious that the new technologies should be integrated into the designed courses (Yacobucci 2012; Lase 2019).

THEORETICAL BACKGROUND

The effectiveness of functioning in the new environment largely depends on the quality of teacher preparation to implement the new education practices incorporating digital literacy (Lase 2019) and transversal skills among the others. "Education 4.0 is a response to the need for the Industrial Revolution 4.0, where humans and technology are converging to create new opportunities creatively and innovatively" (Lase 2019: 49). Fisk (2017) proposed 9 trends related to Education 4.0:

- The physical environment is becoming less important within the education process. The learner is equipped with opportunities to learn anywhere and anytime provided the development and implementation of remote learning and other related practices, such as, e.g., flipped classroom.
- Learning is increasingly becoming student-centred providing the opportunities for personalized input.
- Students are having a choice to decide upon the study form appropriate to their individual needs.
- Project-based learning is becoming one of the central approaches to achieve the objectives.
- Students are increasingly engaged in gaining hands-on experience.
- New assessment types are being developed in response to the necessity to implement the new practices in the delivery of the study courses.
- Students' viewpoints and opinions are becoming of topicality in designing the new study courses.
- The teachers have to reconsider their roles within the education process (e.g., facilitators).
- Students are facing the necessity to critically assess the data they come across dealing with the diverse information (Fisk 2017).

Having taken into account the theoretical basis for the development of the study tools for the Education 4.0, the "concept formation" tool was chosen to promote the acquisition of 21st century skills.

Concept Formation is an inductive teaching strategy that helps students form a clear understanding of a concept (or idea) through studying a small set of examples of the concept (Parker 2016). Belonging to Information Processing Family Models, it increases students' ability to think divergently and flexibly, build concepts and organize information (Joyce et al. 2015). Concepts make up the "backbone" of minds. Concepts are defined as cognitive abstractions which represent classes of things, events, or ideas. In general, concepts are seen as natural semantic categories which help to unite things, qualities, and occurrences on the basis of a similarity of characteristics (Seel 2012). Acquiring a new concept account for knowing more and beyond the definition of a term acquiring the concept based on the examples. "This is deep conceptual learning rather than superficial knowledge of a vocabulary word" (Parker 2016: https://teachinghistory.org). In implementing this tool, it is crucial to keep in mind that "a concept is defined by critical characteristics shared by all examples of the concept". Therefore, examples should comprise all these critical characteristics (ibid.). Some concepts are concrete and straightforward, while other concepts are more abstract. Concrete concepts are learned more quickly and easily than abstract ones (Ormrod 2012).

Explanation of the tool

Concept Formation is a great way for students to understand the concept of something new. A concept is defined by the critical characteristics shared among all examples of it. Students discuss what makes these examples unique or important for themselves in relation to other things. They review sets of examples, and then make deductions about related concepts on their own through these studies without any help from others or resources outside themselves. The implementation process of the tool involves the following steps: enumerating and listing (mental operation: differentiation), grouping and exploring relationships (identifying and abstracting) and labelling and categorising (determining the order). It can be performed on three levels depending on mental functions the teacher wants to activate, or the students are able to perform and the nature of concepts chosen. See Table 1, 2 and 3 (based on Joyce et al. 2015).

Table 1. **Level 1 Concept formation**

Activity	**Mental operations**	**Eliciting**
Enumerating Listing	Differentiation	What did you see? Hear? Notice?
Grouping and exploring relationships	Identifying common properties, abstracting	What belongs together? What picture does it create in your mind
Labeling categorising	Determining the hierarchical order	What would you call these groups? What belongs to what?

Table 2. **Level 2 Interpretation of data**

Activity	**Mental operations**	**Eliciting**
Identifying critical relationships	Differentiating	What did you notice? See? Find?
Exploring relationships	Relating categories Determining cause-effect	Why did this happen?
Making inferences	Going beyond Finding implications	What does this mean? What picture does it create in your mind? What would you conclude?

Table 3. **Level 3 Application of data**

Activity	Mental operations	Eliciting
Predicting explaining Hypothesizing	Analysing retrieving	What would happen if?
Supporting	Causal links	Why do you think this would happen?
Verifying the prediction	Logical principles	What would it take for this to be generally true?

- Aims of the tool – 1) to form students' understanding; 2) to make deductions; 3) to help students understand the fundamental building blocks of something and allow to see connections between different things; 4) to foster students' creativity while giving students an opportunity to develop their own thinking and meaning-making.
- Expected outcome – generated data to be classified, grouped, and labeled or different open classifications of the provided data, there is no one correct answer. Good for vocabulary building and developing students' research skills.
- Allocated time – 30 to 40 minutes (depending on the choice of 7 or 10 steps, as well as concepts – how concrete or abstract they are and how familiar they are to students).
- Setting, place layout – students working in groups from 3 to 5; the group has got a specified working place – separate table per group.
- Necessary materials – one set of concepts per group (self-made cards, realia) with guidelines of task performance in case this is meant for self-directed learning.
- Number of participants – whole class in small groups of 3-5, not limited number of groups, but each group should have a set of materials and working place.
- Role of students – productive and creative, students enumerate and list samples, group them and label.
- Role of teacher – active observer, information elicitor. Teachers would choose for students to do a concept formation activity if it didn't matter very much if they came up with the same concept as scientists or not (if a teacher is mostly interested in students' thinking), or if the science concepts would almost certainly be formed. In other words, the teacher would use it when the particular concept didn't really matter, or when the results would be relatively unambiguous. This is a good tool to use to help students un-

derstand how much things are classified in regular life and how there are different rationales for different classifications.

- Steps to use the tool – depending on the starting point, there are 7 or 10 process steps, namely: listing, observing, examining, grouping, labelling, creating.

Concept formation (Version 1)

1. Divide the students into small groups (3-5 students per group)

   The group should have their own working space – face-to-face: preferably round table;

   online: breakout rooms and google document slide; use https://www.randomlists.com/team-generator

2. Provide the students with a number of items to classify. These items could be real objects, i.e., seeds, "thoughts", ideas, or words.

   e.g., No.1. How would you group these words and why?

   bukë kruh pa ogia leipä pain ħobż pão kenyér

   леб bara arán hlieb ψωμί maize леб Brot duona

3. Ask the students to organize the items into groups according to characteristics of their choice (10 to 15 minutes).

4. Ask students to discuss their grouping rationale.

5. Ask students to label and categorise groups (padlet.com can be used).

6. When classification is complete, have each group explain their grouping rationale to the class and show which groups contain which items (2 minutes per group).

   e.g., groups according to

   the number of letters

   the use of symbols

   the meaning of words

   the number of consonants

   the language trees

7. In order to have the students evaluate the general usefulness of their grouping rationale, provide them with other items to see if they can be fit into the established groups (10 minutes).

   brød brauð pan de molde хляб хліб chleb hljeb brood

Follow-up activities: As all the words mean "bread" in various languages, the students can be given the assignments to explore these languages, match with countries, find out what bread means to them, how bread is made, etc.

Concept formation (Version 2)

1. Students are asked to brainstorm for 3 minutes and put down on their notes, e.g., all possible countries / birds / fruit / values / geographical objects they can mention (choose only one).
2. Students are asked to count items and line up according to their numbers.
3. Divide the students into small groups of 4.
4. Assign roles: *question asker, presenter, timekeeper, moderator, note keeper.*

   If the roles are used for the first time, the students should be given role descriptions, e.g.,

   A QUESTION ASKER is the person who has rights to turn to the tutor with the question if there is something you cannot find out the answer in your group.

   PRESENTER does all kinds of presentations.

   TIMEKEEPER is the person with the watch / phone and who follows the time and instructions.

   MODERATOR leads the group work.

   NOTE KEEPER carries out all the written tasks of the group.
5. Each group is given 40 slips of paper, they have to compare the items in their notes and come up with 40 genuine ones, each item is to be written by the secretary on a separate slip of paper.
6. Ask the students to organize the items into groups according to characteristics of their choice.
7. Ask students to discuss their grouping rationale.
8. Ask students to label and categorise groups.
9. When classification is complete, have each group explain their grouping rationale to the class and show which groups contain which items.
10. In order to have the students evaluate the general usefulness of their grouping rationale, ask them to provide another 10 items to see if they can be fit into the established groups.

    - Assessment – to assess students' understanding of the concept, have them explore new examples and identify those that contain the critical characteristics of the concept and those that do not. Students' work can be assessed by analyzing how they perform the following concept formation steps: listing, observing, examining, grouping, labelling, creating, defending one's point of view.

- Students' feedback:

"This tool is structure oriented. It involves comparative thinking, symbolic representation and logical reasoning."

"Concept formation is not related to simple recall; it must be constructed."

"It encourages critical and creative thinking, communication, and independent learning. Inculcates personal and social values and skills amongst the students if they work in a positive way with their peers."

"Concept formation develops students' abilities to observe items thoroughly. It helps them discover the methods of classification."

"By concept formation tool, I learned the word bread in many different languages, because while working in groups we needed to figure out what was common between many given words - and as it turned out, they were all the same word "bread" but in different languages. This kind of task helps students to brainstorm their ideas about a topic that they probably have zero knowledge of. For example, the chosen languages were very specific and less known, so the task was challenging. Working in groups helped put the puzzle pieces together, each of us gave some ideas or information that we could work on til it made sense."

"First idea that inspired me was the task where me (and our group) had to match a list of words and try to find similarities. (One step concept formation – grouping different words in categories) with no wrong or right answers. In our group we matched them by number of letters and umlauts (Umlaut is a mark used over a vowel, to indicate a different vowel quality). It inspired me because I could essentially use this activity for teaching English, but also for different subjects."

Visualized examples (the works of students classifying the words of bread in several languages).

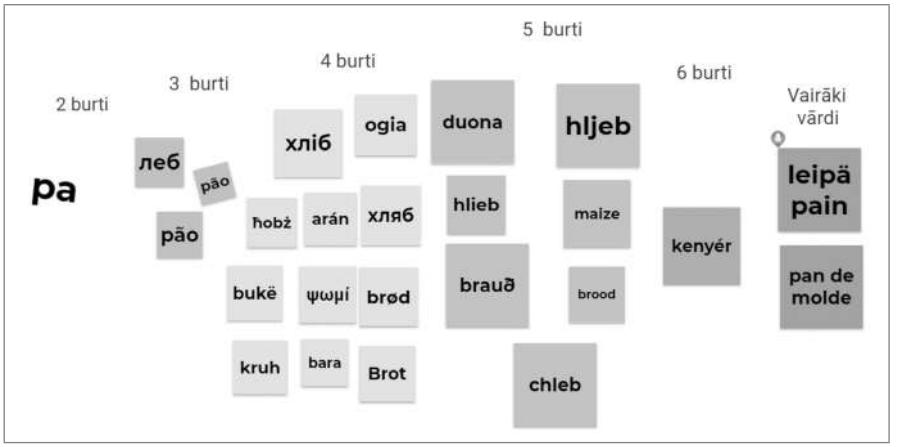

Figure 1 - Classification according to the number of letters (2 letters, 3 letters, 4 letters, 5 letters, 6 letters, many words)

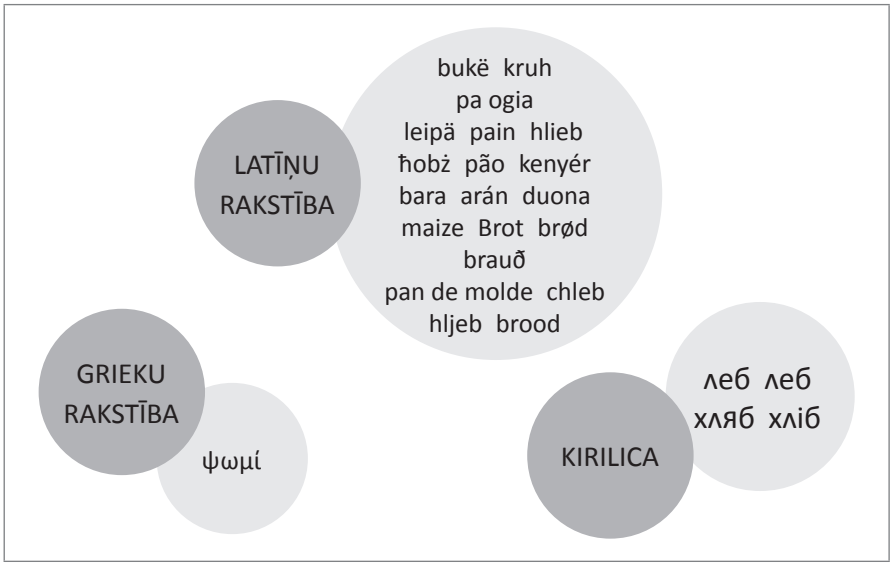

Figure 2 - Classification according to script (Latin script, Greek script, Cyrillic script)

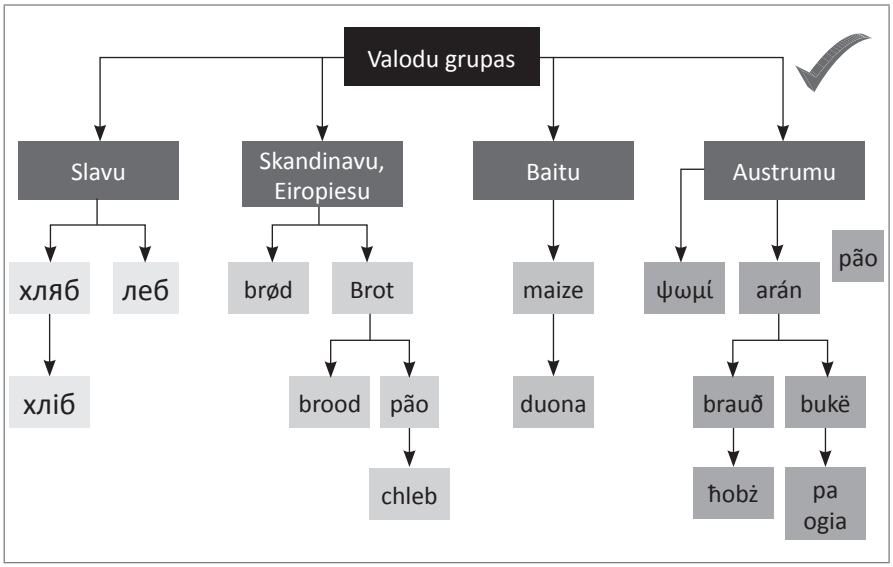

Figure 3 - Classification according to the language groups (Slavic, Scandinavian, Baltic, Oriental Language Group)

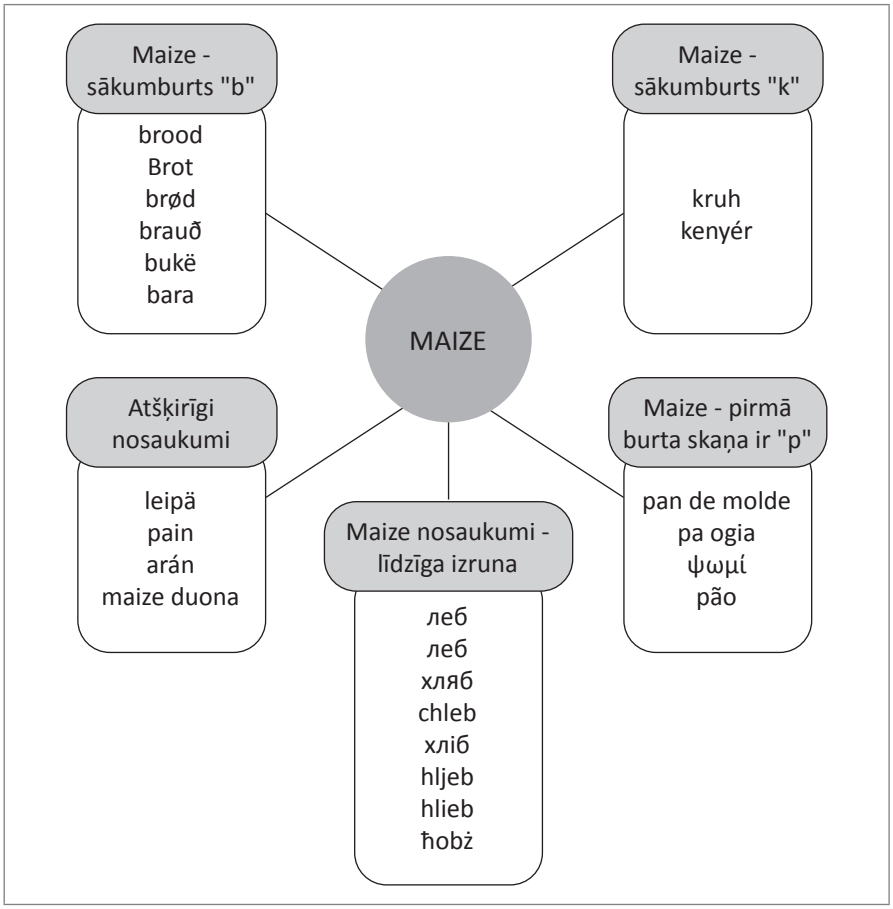

Figure 4 - Classification according to pronunciation (starts with letter "b", starts with letter "k", starts with letter "p", other names, similar pronounciation)

CONCLUSION

The above-stated examples accompanied by the brief theoretical background are aimed at shedding light upon the implementation of the "Concept Formation" tool for in-service and pre-service teachers. Based on the information provided in this chapter, the conclusion can be drawn that the "Concept formation" is crucial within the teaching and learning process provided that these are the building blocks for the students to understand the connections and distinguish among categories built within the inductive approach application. In addition, it is crucial to highlight that through categorizing objects, ideas and events people/ students make sense out of the world.

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