

Flashcards for Organic Chemistry

– Stimulating recall

Irmina Buczek, Marcin M. Chrzanowski, Małgorzata Musialik,
Beata N. Gawrońska, Michał Zarzycki

„School should be the best place
for an entertainment”
Peter Kline
(The Everyday Genius)

GO to the end
and download flashcards!

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mgr Irmina Buczek: Educational Research Institute, Science Section, ul. Górczewska 8, 01-180 Warsaw



mgr Beata N. Gawrońska: University of Warsaw, Faculty of Biology, Biology Teaching Laboratory, ul. Miecznikowa 1, 02-096 Warsaw

How to learn (teach) to remember?

The vast number and wide variety of types of organic compounds can create problems for students who need to remember structures, formulas, nomenclature and how to distinguish between functional groups of individual compounds. This is needed to assess their physical and chemical properties. Classification of organic compounds according to structural or semi-structural formulas is, therefore, important knowledge for students. The core curriculum for chemistry at the 3rd stage of education requires that students are able to identify the alkanes, alkenes, alkynes, alcohols, carboxylic acids, esters, amines and amino acids (Ministry of Education, 2008). Artful presentation of the structures of these molecules may assist in learning organic chemistry.

The learning process is complex and for the teacher to transfer sustainable knowledge to students can be a major challenge. The durability of knowledge is not only dependent on assimilation but also on teaching methods used. Mrowiec (1993) argues that systematic application of information learned during activities favours consolidation. Consistent repetition of actions reduces the initial concentration needed and allows activities to become automated. The student is then able to focus on other matters. Therefore, it is important to assess how much repetition is needed to structure new knowledge correctly (Mrowiec, 1993).



dr Marcin Chrzanowski: Educational Research Institute, Science Section, ul. Górczewska 8, 01-180 Warsaw



mgr Michał Zarzycki: University of Warsaw, Faculty of Biology, Department of Immunology, ul. Miecznikowa 1, 02-096 Warsaw

A major difficulty for teachers preparing classes is to adapt to different types of intelligence and styles of teaching. There are many methods that can be used to determine dominant learning style. According to Linksman (2005), there are four main learning styles: visual, auditory, tactile and kinesthetic. Research shows that about 30% of students remember what they hear during classes and another 40% remember what they have read or seen. Fifteen percent respond to tactile learning. These students use their hands and fingers to associate what they are learning with their sense of touch and emotions. Pupils, who acquire knowledge kinesthetically (about 15%), learn best when they can perform some physical activity during learning activities. These students learn best while they are moving. In the traditional system of education, students especially vulnerable to failure are those who learning style is kinesthetic or tactile (Dryden & Vos, 2003). To ensure the development of all students, different approaches to teaching should be adopted. Listening and reading only influences certain brain structures. Activation of additional senses, e.g., through hands-on learning, stimulates other areas of brain. If teachers do not employ a variety of teaching methods, some students may be uninvolved and bored during a lesson.

Memorization is only one aspect of learning. It is also important to access stored information. Activation of access to these memories aids recall by the strengthening of neural pathways. Use of plays and didactic games



dr Małgorzata Musialik: Educational Research Institute, Science Section, ul. Górczewska 8, 01-180 Warsaw



can be an excellent opportunity to boost the learning of students, considering the aspects of the learning process mentioned above (Kaminska-Ostę, 2012).

The aim

The article describes methods and teaching aids aimed primarily at consolidation of selected information about the organic compounds specified by the core curriculum for the 3rd stage of education.

Two methods are presented: the first, which is based on flashcards and the second – in the form of a card game for students. The comments of the teacher who conducted lessons using the described methods in five classes of middle school in organic chemistry were included in the description.

The following printed sheets are suggested:

- A1 (semi-structural formulas and names of alkanes)
- A2 (semi-structural formulas and names of alkenes)
- A3 (semi-structural formulas and names of alkynes)
- R (basic characteristic reactions of organic compounds),
- W (general formulas for groups of organic compounds),
- K (classification of selected organic compounds),

Different sets of cards and sheets can be used in a variety of potential configurations during classes. The sheets should be printed on A4, single or double-sided (instructions given below) and cards cut out as flashcards. The number of sheets should be appropriate to the number of students in the class and method planned.

How to use teaching aids from this article?

The first method targets independent student revision at home or during lessons. Students are responsible for monitoring their own progress and evaluation. They repeat an exercise until they make no mistakes when they see the flashcards. Another method is for students to work in pairs. One student validates responses provided by their partner and then they switch roles. The following two approaches can be used for groups of more students. These methods introduce an element of competition between participants, one of whom becomes the winner. To strengthen concentration and motivation of pupils, a good grade can provide further reward to the student with the highest score.

Exercises should be performed systematically, successively adding new groups of compounds: first alkanes, then alkenes and alkynes, then repeating with the three groups of hydrocarbons. Additional sheets of compounds mentioned in the core curriculum, such as alcohols and carboxylic acids, can then be prepared. In the following lessons, sheets for the functional groups, classification of compounds and the characteristic reactions can be used. It is important not to use all sheets and methods for just one lesson. Table 1 shows content of the core curriculum for the 3rd stage of education, which can potentially be taught using corresponding work sheets.

Method for working with flashcards for organic chemistry

Each flashcard is a piece of card or paper displaying a word, pattern or question on the face side and the definition, translation, explanation or answer on the reverse.

Core curriculum for third stage chemistry	Work sheet type					
	A1	A2	A3	R	W	K
8.2) define concepts of saturated and unsaturated hydrocarbons;				+		+
8.3) create formulas for homologous series of alkanes (...) and create the molecular formula of alkane having given number of carbon atoms.	+				+	+
8.4) (...) describe chemical properties of the (combustion) alkanes (...);				+	+	+
8.6) give the general formula for homologous series of alkenes and alkynes; provide rules for naming alkenes and alkynes based on the names of alkanes;		+	+		+	
8.7) describe the properties (combustion, bromine and hydrogen addition) (...) of ethene and ethyne;				+		
8.8) (...) experiment to distinguish between saturated and unsaturated hydrocarbons;				+		
8.9) (...) ethene polymerization reaction equation; (...)				+		
9.1) derive names of simple alcohols with their written summary and structural formulas;					+	+
9.4) (...) draw structures of simple carboxylic acids and give their systematic names;					+	+
9.6) explain the esterification reaction; (...);				+	+	+
9.11) describe the structure of (...) derivatives of nitrogen-containing hydrocarbons exemplified by amines (methylamine) and amino acid (glycine);					+	+
9.13) (...) describe the differences between denaturation and coagulation of proteins; (...); detect the presence of protein in a variety of foods;				+		
9.15) give the empirical formula of glucose and fructose; (...);				+		
9.17) (...) detect the presence of starch in various foods.				+		

Table 1. Content that can be introduced to chemistry classes using sheets: A1, A2, A3, W, and K

Flashcards – For individual students (3-5 minutes per sheet)

1. Sheets should be printed double-sided and flashcards should be cut out.
2. Flashcards should be placed in a pile on the desk so that only the face side is visible.
3. The student takes a flashcard from the pack, reads the question and if he knows the answer, he puts the card onto a new pile. If he does not know the correct answer, he turns the flashcard over and reads the answer, putting the card back to the bottom of the pack.
4. The process continues until all the flashcards are on the second pile (with the correctly solved questions).

Flashcards – Work in pairs (3-5 minutes)

1. Two or three sheets should be printed double-sided and flashcards cut out.
2. Flashcards should be placed in a pile, so that only the face side is visible.
3. During the activity one student answers questions and their partner checks for correctness.
4. One student takes flashcards from the stack and reads the question to their partner.
5. If the student knows the answer, their partner puts the card onto a new pile. If the answer is not correct he turns the flashcard over and reads the answer, putting the card back at the bottom of the pack.
6. After obtaining correct answers to all questions, students switch roles.

Flashcards – Work in groups of four (7-10 minutes)

1. Two sheets of flashcards should be printed single sided (40 cards) and flashcards cut out.

2. Two sets of flashcards should be placed on the desk with the face up and another two face down.
3. Students try to pair flashcards sequentially (face with the appropriate reverse).
4. If a student pairs two cards correctly he scores a point.
5. The game continues until all cards are paired.
6. The student who scores the most points is the winner.

The card game, "STRIFE", using flashcards (45 minutes)

Flashcards cut out from the sheets can be used as a card game, the rules of which are based on a game produced by Mattel¹. The game can help memorize formulas and names of individual groups of hydrocarbons. This time, single-side, printed flashcard sheets A1, A2 and A3 should be cut out. There should now be 56 cards for the pack. Additionally, sheet S (an additional 20 cards) should be printed as action cards. The class should be divided into several groups so that 6 to 8 students form each group. A pack of the cards should be given to each group. Each group should also be provided with some blank tables for scoring. The paper used could be in different colours so that groups can easily identify them and continue the game in their next lesson, avoiding confusion with other groups.

The instructions and rules for the game are described below.

1. Construct for the game

The pack is of 76 cards, including some regular cards:

- 10 cards – names of alkanes,
- 10 cards – semi-structural formulas of alkanes,
- 9 cards – names of alkenes,
- 9 cards – semi-structural formulas of alkenes,

¹ <http://www.grymattel.pl/docs/UNO.pdf>

- 9 cards – names of alkynes,
 - 9 cards – semi-structural formulas of alkynes,
- And function cards:
- 4 cards – „Take Two”,
 - 4 cards – „Change Direction”,
 - 4 cards – „Stop”,
 - 4 cards – „Choose Series”,
 - 4 cards – „Choose Series + Take Four”.

2. Game objective

The objective of the game is to discard all cards as quickly as possible in a round and to score points for all cards that still belong to other players. Points gained in successive rounds are totalled. The winner is the first to score 300 points.

3. Preparation for play

1. Each player draws a single card; the cards are then dealt by the player who drew the highest card (hydrocarbon with the largest number of carbon atoms); function cards count as zero.
2. The dealer, shuffles the pack and deals 7 cards to each player.
3. The remaining cards in the deck are placed face down to create the DRAW pile.
4. The card on the top of the DRAW pile should be turned over and used as the first card for the STRIFE pile. ATTENTION: If a function card is drawn as the starting card, then players should follow the instructions given in: ROLES OF FUNCTIONAL CARDS.

4. Play

1. The player sitting to the left of the dealer begins the game.
2. This player should place one of their cards on the STRIFE pile. This card should feature a hydrocar-

bon from the same homologous series (formula or name) or a hydrocarbon that has the same number of carbon atoms in its molecule as the hydrocarbon shown on the top card of the STRIFE pile.

EXAMPLE: If there is an “ethane” on the STRIFE pile, then a player can play “ethene” or “ethyne” or $\text{CH}_3\text{-CH}_3$ or $\text{CH}_2=\text{CH}_2$ or $\text{CH}\equiv\text{CH}$ (equal number of carbon atoms to ethane) or the card “choose homologous series” (see instructions below for ACTION CARDS).

- If the player does not have a suitable card that to place on the STRIFE pile, then they take an extra card from the DRAW pile. If the card then drawn is an appropriate match for the card on the STRIFE pile, the player can play it. Otherwise, it is the next player's turn.
- Players may sometimes NOT play a card from their own hand, although they might hold one suitable to play. In this case the player takes a card from the DRAW pile. If this new card is valid, it may be used in the same round, but after drawing it, it is forbidden to play another card from this hand in the same round.

V. Role of action cards

- The card “Take Two” – if someone plays this card, the next player has to take two cards and loses their turn. This card can only be played onto a card which shows a formula or the name of the same homologous series. It can also be played on the card “Take Two”. If this card is revealed at the beginning of STRIFE, then it operates in the same way as described.
- The card “Change Direction” – after this card is played, the direction of play changes (if the game was so far clockwise, then play would now proceed anti-clockwise or vice-versa). If the card is revealed

at the beginning of STRIFE, the dealer starts the game and the game runs clockwise, not anti-clockwise.

- The card “Stop” – if this card is played, then the next player loses their turn and has to “stop”. If the card “Stop” is revealed at the beginning of STRIFE then the player to the left of the dealer loses a turn and the game is continued by the player to their left.
- Card “Choose Series” – The player who plays this card sets the homologous series of hydrocarbons to continue the strife. A player can elect to play the “Choose Series” card, even if their hand holds another valid card. If the card “Choose Series” is revealed at the beginning of STRIFE, then the player to the left of the dealer sets the homologous series to continue STRIFE.
- Card “Choose Series + Take Four” – this card allows choice of the homologous series of hydrocarbons for continuation and it also requires the next player to take 4 cards from the DRAW pile, in addition they miss their turn. But that is not everything! A player can only play this card if they DO NOT HAVE any other cards in the same homologous series as the card on the STRIFE pile. If this card is revealed at the beginning of STRIFE then it should be returned to the pack and the player should draw another card.

ATTENTION: If a player suspects that the previous player played the “Choose Series + Take Four” card, breaking the rules (i.e., the player who played it also had a valid card in their hand), then they may challenge the player. The suspected player then has to show their cards to the player who made the challenge. If the suspect player proves guilty, they have to draw 4 cards instead of the next player. However, if the suspect player is in-

nocent, then the player who made the challenge has to draw 4 plus 2 extra cards (6!).

Finishing STRIFE

- After playing a card, leaving only one remaining in their hand, the player has to declare “last card”, to inform the other players. If this player does not declare “last card” and is caught out by another before their next turn, they have to take two extra cards.
- If a player has no cards, then the round is finished. The game starts again after counting points (see: „COUNTING POINTS „).
- If the last used card is “Take Two” or “Choose Series + Take Four”, then the next player must take either 2 or 4 cards. These cards are added to their total score.
- If nobody has discarded all of their cards before the DRAW pile is empty, then the STRIFE pile cards must be shuffled and the game continues using these as the new DRAW pile.

Counting points

The player who first discards all their cards in a round, scores points for every card still in other players' hands. Points are counted according to the rules described in the Table 2.

Table 2. Counting points

Types of cards	Number of points
Cards showing the formulas or names of hydrocarbons	Value corresponds to the number of carbon atoms in the molecule.
„Take Two“.	20 points
„Change Direction“	20 points
„Stop“	20 points
„Choose Series“	20 points
„Choose Series + Take Four“	20 points

If nobody has scored 300 points, then the cards must be reshuffled and new hands dealt for further play.

The winner

The winner is the player who first scores 300 points.

DOWNLOAD FLASHCARDS:

- alkanes:
http://ebis.ibe.edu.pl/flashcards/cards_alkanes.pdf
- alkenes:
http://ebis.ibe.edu.pl/flashcards/cards_alkenes.pdf
- alkynes:
http://ebis.ibe.edu.pl/flashcards/cards_alkynes.pdf
- classification:
http://ebis.ibe.edu.pl/flashcards/cards_classification.pdf
- functional groups:
http://ebis.ibe.edu.pl/flashcards/cards_functional_groups.pdf
- reactions:
http://ebis.ibe.edu.pl/flashcards/cards_reactions.pdf

Literature

- Dryden, G., Vos, J. (2003). *Rewolucja w uczeniu*. Poznań: Zysk i S-ka Wydawnictwo.
- Linksman, R. (2005). *W jaki sposób szybko się uczyć?* Warszawa: Świat Książki.
- MEN. (2008). Rozporządzenie Ministra Edukacji Narodowej z dnia 23 grudnia 2008 r w sprawie podstawy programowej wychowania przedszkolnego oraz kształcenia ogólnego w poszczególnych typach szkół.
- Mrowiec, H. (1993). *Utwalanie wiedzy w kształceniu chemicznym*. W A. Burewicz, & H. Gulińska, *Dydaktyka chemii* (strony 213-238). Poznań: Wydawnictwo Naukowe UAM.
- Żylińska, M. (2013). *Neurodydaktyka. Nauczanie i uczenie się przyjazna mózgowi*. Toruń: Wydawnictwo Naukowe UMK.