Education and Culture
Lifelong learning programme
COMENIUS

Teaching Material

Lego Robot and Coordinate System

Coordinate system is nothing but a simplified and formalized way of orientation. Of course, in this lesson we only talk about orientation in a (flat) plane.

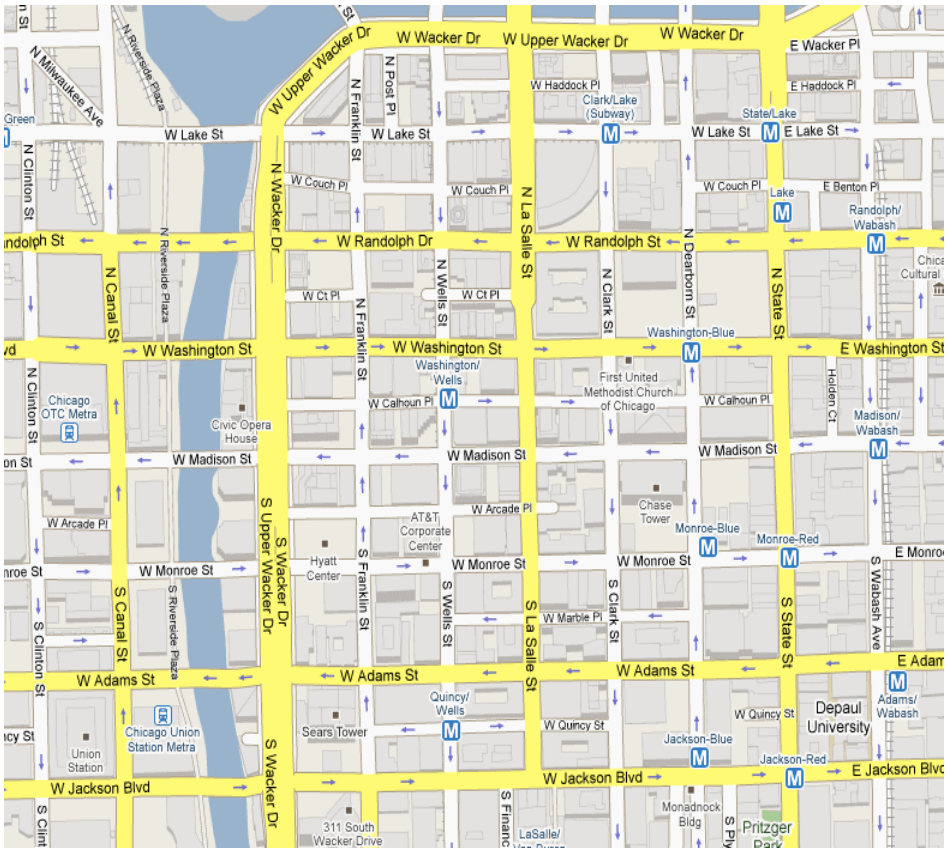
This lesson is just a draft of simple ideas and not a detailed lesson.

A web version of the lesson with useful interactive simulations can be found at http://uc.fmf.uni-lj.si/com/Lego/lego.html.

Coordinate System in Real World

We could start by showing a picture or a map of a city, and giving directions from one point to another. Depending on students we can go into more or less details. Even for teachers it might be interesting that for old cities like Paris (on a picture below) a 'polar coordinate system' would be more appropriate than a 'Cartesian coordinate system'. Discuss the orientation in a city like Paris bellow and think about the polar coordinate system.

More modern cities were built differently. For the map of Chicago bellow a Cartesian coordinate system seems perfect. Even the names of streets follow the Cartesian coordinate system logic of East-West and South-North. Discuss the orientation in a city like Chicago bellow and think about the Cartesian coordinate system.



Letting a student think and explain how to get from (for example) subway station to museum is exactly the essence of Cartesian coordinate system.

Modern computer technology can be used to make students practice the idea of coordinate system and to simulate many real life situations. On the mentioned web version of this lesson one can experience some of such interactive simulations.

Lego Mindstorms NXT robot

Lego Mindstorms NXT is a simple robot which we can command remotely by a computer via Bluetooth, or we can load a pre-programmed program (sequence of moves) via USB cable. A part of a Lego Mindstorms NXT is graphical programming language which allows us to program the robot by visual means. A program is built up as a sequence of moves by 'Lego logic' just by 'connecting blocks'.

We will not explain the details here, but it can be an interesting toy and a motivating didactical tool. The robot and software allows many options and has different sensors which can be managed and incorporated in 'conditional reactions' of a robot. For our purposes we would only like to emphasise a very basic options of 'forward moves' and turns. Positioning a robot and a piece of paper on two different positions in a room already poses an elementary (coordinate system) problem: *Make the robot move to end up on the paper!*

At the beginning we need to prepare the program for students so that the task for them is easy. Basically, they experience exactly the coordinates, as they need to count and measure. For example '4 ahead - turn left - 3 ahead' will mean exactly the point (4,3) in coordinate system with appropriate unit. After students master the ba-

sics, we can play on with barriers. There will be lots of try and error with lots of fun and learning. And finally, there will be lots of real life experiences, difficulties and realizations how hard it is sometimes, to make it exact in real life. That might even make mathematics more fun. (On the web version of the lesson one can see some of the actions of the robot as it was programmed by children.)

Comments

It really depends on teachers devotion, time, and skill, how far one can take students, how much they will learn and how much fun they might have. Older students, say 14-18, we can only introduce to Lego Mindstorms and challenge them to explore the possibilities by themselves. There are plenty of possibilities.

For those, who will want to learn more, we can tell that besides great opportunities the Lego Mindstorms offers, there are also unfortunate facts one encounters while working with Lego Mindstorms. For example, the robot also plays sounds and we can make it 'speak'. It is fun for kids if a robot says 'I am turning right' before it turns right. But there is a problem. The robot has its sounds in a special RSO format and even the Lego information says that the sounds are only in English... But you can record your own sounds (in any language) for example in WAV format and transform them to RSO format with a very simple and free program (found on the web) and use it with the robot. Well, the real problem is that the robot only has a 256 KB of memory, which is really a shame in the time of 64 GB flash-sticks. So only short (and with few sounds) programs can be loaded to a robot.

Also the logic of visual programming with 'Lego blocks' requires some time to master.

Furthermore, mechanics with which we manage the movements of a robot is a 'real life'.So it is close to impossible to get 'mathematically exact behaviour'. Nevertheless, Lego Mindstorms is a toy and a tool useful for learning and therefore worth learning.

Conclusion

As mentioned, the lesson is rather a challenge than a finished lesson. Hopefully, it offers some ideas to approach to the 'formality of coordinate system' with some real life experiences. Let us finish with an idea which can be used with more advanced or smarter students to further the understanding of coordinates. Say a helicopter takes off in your home town and flies 1000 km North, then 1000 km West, then 1000 km South and finally 1000 km East. Would it land in your home town? Discuss the properties of mathematical coordinate system and of the North-South-East-West orientation we use... On the web version of the lesson a nice applet simulates such movements.

Interactive simulation

Mentioned interesting interactive computer simulations of the ideas presented can be found and studied on the web.

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