

## From quarks to atoms: A demonstration for blinds

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Popular physics issues like CMS experiment are familiar for students but some terms like bosons, mesons, hadrons, and leptons may be so similar to confuse. It seems harder for a blind student to construct the atom from quark (Zetie, 2003). To overcome the problem an appropriate demonstration for blind students was prepared.

There are some small (for gluon) and big (for atom) spheroid toys, different ropes (for different type of quarks) and dress button (for anti-quark). These simple materials (figure 1) are used to demonstrate the structure of atom for a blind student.



Figure 1. Materials for demonstration

Both literature about blind students' experiences on learning physics and how to organize particle physics courses are not adequate to lead teachers (Bülbül & Eryılmaz, 2012). The purpose of the study is to guide physics teachers how to direct their course for blinds through particle physics. For this purpose blind participant had chosen two type of rope for up and down quarks and put into a small spheroid toy to demonstrate a proton or a neutron (figure 2). Baryons, mesons and hadrons are discussed through the construct. It is an open demonstration that different types of materials may include for different type of particles like pions or leptons.

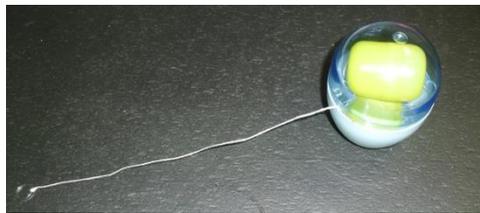


Figure 2. Basic atomic model

During the study a table which includes explanations about the role in atoms and how to spell the term is given to blind student with Braille. Although the student attends 9<sup>th</sup> grade and the unit related with this topic is at 12<sup>th</sup> grade in Turkey, she emitted that there was no difficult part with the demonstration. After demonstration she looked through the table several times and said that she is ready to answer the questions. There were some basic questions like quark structure of protons and definitions of mesons. She answered the questions correctly. Additionally one more question she asked whether quarks (rope) are fissionable or not. Examining this question is one of the objectives of Turkish High School Physics Curriculum. She reached this question while playing with the rope (quarks).

It is important that all analogies like this demonstration has possibilities to make wrong connections in students' mind and teachers should emphasize these points. For

instance, gluons are not solid like the small toy used in demonstration. During the study, she asked another interesting question; whether the atom or protons really look like sphere.

We may categorize questions into three type; namely, material centered questions, material and conceptual questions and conceptual questions. The last type of questions means that student understands the material (asked questions about material and learnt) and material concept relationship (asked material and conceptual combined questions and learnt).

This demonstration is useful for all students and for inclusive physics classes because materials make the subject tangible and playable. The only important thing is organizing the presentation parallel to the simple structure of materials. We should not forget that one time practice may not be enough, so they may need to repeat their practice.

## **References**

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