

## Chapter 38

# Identifying Students' Meta-Competences During Laboratory Work on a Unique Scientific Equipment

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### ABSTRACT

*The chapter is devoted to the development of an analytical methodology of forming future engineers' meta-competences (interdisciplinary, meta-creative, and meta-cognitive) when he/she works on unique scientific equipment. The authors research a hypothesis about the possibility of estimating quality of education and identifying competences in engineering courses by measurement of students' activities as well as outcomes. An example is described of the criterion revealing during laboratory work with a scanning probe microscope "Nanoeducator." The experiment is a part of a multifunctional scientific complex for the development and research of thin films. Results of the parameter evaluation are shown in graphs using MATLAB software. This chapter is a new direction towards discovering methods and algorithms to define and evaluate future engineers' meta-competence.*

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## **INTRODUCTION**

This chapter is devoted to the development of an analytical methodology of forming future engineers' meta-competences (interdisciplinary, meta-creative and meta-cognitive) when student works on unique scientific equipment. The authors investigate a hypothesis about the possibility of education quality estimation and competences' identification during the engineering courses by measurement of student's activities. An example is described of the criterion revealing during laboratory work with a scanning probe microscope "Nanoeducator". The experiment is a part of a Multifunctional scientific complex for the development and research of thin films. Results of the parameters' evaluation are shown in graphs using MATLAB software. The first part of the chapter describes the Unique Scientific Equipment (hereinafter referred to as USE), the second part of the chapter is about the methodology of student's meta-competence's criterion mining at the different stages of the laboratory work, the third part describes the relationships between six mined criterion and student's meta-creative, meta-cognitive and meta-subject competences. The last fourth part shows the results of the experimental research and analyse made by authors over the group of students' laboratory work.

## **BACKGROUND**

The problems on how to form students' meta-subject, meta-creative and meta-cognitive competences are under consideration nowadays (Cruz B., 2013; Greshilova A., 2014; Scharnhorst, 2016). Automation of assessment of the student's competencies is an actual problem also. The solution is dedicated to the work (Galiamova E. 2009; Avdeeva Z., 2007). This chapter discusses the possibility of criterion's revealing which determines the meta-competences in the process of students' laboratory work on USE. The results of joint studies performed by the Bauman Moscow State Technical University and the Ryazan State Radio Engineering University, prove this hypotheses.

## **UNIQUE SCIENTIFIC EQUIPMENT'S DESCRIPTION**

The Educational-scientific complex based on scanning probe microscope "Nanoeducator" is a part of a Multifunctional complex for the development and research of the thin film's parameters. It was named as the USE and placed at the Ryazan state radio engineering University for other Universities scientific research as well. The complex of scientific equipment has no analogues in the Russian Federation, it is functioning as a single entity and established the scientific and educational organization in order to obtain scientific results, the achievement of which is not possible when using other equipment (Russian Federation Law No. 270-FZ dated 13.07.2015).

The USE includes equipment adapted to research the grown nanoscale films and layers in the educational environment, Nano laboratory probe microscopy with the same name "Nanoeducator". During the experiment's preparation students use the theoretical materials and methodological instructions which are posted at the website of equipment's developer, the NT-MDT company ([www.ntmdt.ru](http://www.ntmdt.ru)), they use also the methodical materials created by the Regional Centre of Probe Microscopy for the collective usage by

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