

# Reflection Report

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## 1. CBC, CBE, and CBA as a System

CBC, CBE, and CBA are acronyms for different approaches in educational system. I have deepened my understanding of the approaches that while CBC sets target orientations for learning, CBE focuses on active learning activities of learners, whereas CBA measures achieved competencies. It leads to shifting the focus from knowledge accumulation to skill application in real contexts. In implementing CBE and CBA during professional development courses, initial challenges arose—for instance, some students excelled theoretically during physics field trips but struggled with practical skills. Teachers then applied CBE to develop targeted skills and students began to demonstrate these skills. However as theoretical and practical skills of the students were evaluated equally, grades were initially low. This led to a revision of the grading system and an updating of the CBA method based on specific competencies. As a result, students not only acquired necessary skills but also benefited from a fair and accurate assessment. High trainee engagement was observed through active learning methods, including data analysis and drawing conclusions. An area for improvement is differentiated support: despite personalized instruction, some learners lacked time for deeper reflection. Future efforts could enhance adaptability and offer more flexible learning pathways. Practical integration of CBC, CBE, and CBA was realised during high school students' preparation for a gas technology research project using PhET simulations. CBC ensured the focused formulation of tasks aimed at describing and modeling gas properties. CBE provided carrying out the case assignments and project activities in groups. CBA gave the presentation

of analytical reports with reasonable conclusions. Coherent implementation of the components ensured strong outcomes with students demonstrating competencies and receiving constructive feedback.

## 2. Curriculum Development and Learning Goals

In the context of competency-based training (CBC), the trainees and I deeply realized during the session the importance of constructive alignment between learning objectives, teaching methods and assessment procedures. We define qualitative objectives as specific, measurable and achievable formulations of observable student behavior, built on the SMART principle. In our own practice, when implementing a lesson on “Thermal Processes” using the PhET simulator, we were convinced of the effectiveness of integrating clearly formulated objectives and the developed assessment rubric. The objective: “Analyze the influence of parameters on the efficiency of a heat engine through simulation” allowed us to set a clear vector of learning activities: students formulated hypotheses, conducted simulations using the PhET simulator, collected and analyzed data, and drew conclusions about the dependence of efficiency on various parameters. We used a rubric with clear descriptors reflecting levels of mastery through observed behavior, which ensured validity and reliability of the assessment. High-level questions (using Bloom's Taxonomy) and formative assessment with feedback to promote metacognition were used. We were able to take into account the diversity of students by varying the complexity of the tasks and the form of presentation (poster, presentation, oral report). For improvement, we have planned to introduce examples of successful and less successful work, as well as self- and peer-assessment based on a rubric. This experience confirmed that the integration of SMART objectives, active methods and objective assessment is the basis for a productive competency-based approach.

## 3. Assessment Quality: Validity, Reliability, and Fairness

Working with assessment in the context of the competency-based approach, I have become more aware of the importance of integrating principles such as validity, reliability and fairness. Competency-based learning requires assessment not only of the knowledge component, but also of observable behavior - the actual actions of learners in solving practical problems. Therefore, it is critical to ensure alignment between learning objectives, teaching methods and assessment methods. During the implementation of the lesson on “Body Movement on an Inclined Plane”, we realized the importance of constructive alignment between objectives, methods, and assessment. Using a rubric with clear descriptors ensured validity, reliability, and consistency of assessment. Giving learners a choice of format for presenting results promoted

diversity and equity. The experience of developing and analyzing a test on the topic “Electric Circuits” was successful. The assessment objectives were clearly linked to the required competencies: circuit assembly, measurement, graphing and data interpretation. This ensured high validity. The use of a rubric with point levels (0-3 points) for each criterion made it possible to achieve reliability and consistency of assessment. Students' works were checked equally regardless of the examiner. Example of a rubric: Assembling a chain: 3 b. - the circuit is assembled correctly; 2 b. - minor errors, 1 mark. - serious errors, 0 b. - The circuit is not assembled; Measurements: 3 b. - accurate and complete, 2 b. - minor errors, 1 b. - serious errors, 0 b. - absent; Graph (I-U): 3 b. - correct graph, correct scale, 2 b. - minor errors, 1 mark. - significant errors, 0 b. - no graph; Interpretation: 3 b. - correct resistance calculation and explanation, 2 b. - partially correct, 1 b. - incorrect, 0 b. - missing A rubric with clear descriptors ensured validity and objectivity, and variability in the forms of presentation of results (presentation, poster, oral report) promoted fairness and consideration of learner diversity. Inclusive approaches were used to improve fairness: learners were offered a choice of formats for presenting the results and different levels of assignments. This allowed individual differences and levels of preparation to be taken into account. However, the need for greater transparency of expectations was identified - the lack of samples of completed work made it difficult to understand the criteria. In the future it is planned to include such examples to increase awareness and fairness of assessment.

## 4. Grading and Standard Setting

Working on courses with students in the context of competency-based learning, we have seen the importance of using evidence-based tools to analyze the quality of assessment materials. Metrics such as reliability coefficient (Cronbach's  $\alpha$ ), task difficulty (P-value), distractor efficiency (A-value), discriminatory indices (Rit, Rir), and standard error of measurement (SEM) have come into focus. These indices contribute to the accuracy and fairness of the assessment and help to identify the strengths and weaknesses of the learners. In the example of the diagnostic test on Ohm's Law and the work of electric current (20 tasks, mixed format), it was possible to achieve  $\alpha = 0.82$ , which indicates a high internal consistency. The tasks with  $P < 0.20$  and  $P > 0.90$  were revised. Thus, the question «Formulate Ohm's law» was too simple ( $P \approx 0.95$ ), and the task with the calculation of current through a thermistor was too complex ( $P = 0.18$ ). The optimal was the task with  $P = 0.63$ , in which students explained the change in current with increasing voltage, correctly applying the formula  $I = U/R$ . Threshold scores were set based on difficulty, program objectives and previous results. With 20 assignments (14 basic, 6 advanced), credit was provided with 10 points (50%), high marks from 17 points and higher, including the solution of complex problems on combined circuits. This ensured compliance with the learning objectives: mastering basic concepts and the ability to apply them

in non-standard conditions. The following measures are planned to improve the quality of assessment: - improvement of distractors taking into account typical difficulties of students identified during the analysis of results; - organization of repeated performance of tasks taking into account individual feedback aimed at correction of gaps and development of meta-skills; - use of digital tools with the possibility of adaptive automated feedback (e.g. Google Forms with branching and explanations). These approaches ensure objectivity and transparency in assessment and contribute to the development of students' self-analysis and self-regulation skills.

## 5. Use of Rubrics

While working on the topic of rubrics within the competency-based approach, my students and I came to the conclusion that a rubric is not only a tool for objective assessment, but also a means of developing meta-skills, independence and reflection. I learned to build alignment between learning objectives, tasks and assessment criteria, which significantly increased the validity and awareness of the educational process. From my practice, during the refresher course, students had to develop a rubric to evaluate the laboratory work "Determination of the focal length of a collecting lens" on the topic "Geometrical Optics". As they worked, they formulated criteria and descriptors with consideration of learning objectives, student proficiency levels, and principles of practice-oriented learning. Purpose and Hypothesis (0-2 points): formulating a purpose and hypothesis, e.g.: "The focal length of a lens remains constant at any distance from an object." Constructing an experiment (0-3): setting up equipment correctly, accuracy in measurements. Data collection (0-3): table with measurements of object and image distances. Conclusions and analysis (0-4): calculation of focal length, explanation of the result, pointing out sources of error. The rubric was used for formative assessment. Learners received interim feedback and corrected work. This promoted mindfulness - one of the trainees independently recalculated the data after analyzing the descriptors, demonstrating reflection. Success was ensured by the clear criteria, their relevance to the aims of the assignment and the use of a rubric for self-assessment. In the future, it is planned to involve trainees in the development of criteria to increase motivation.

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