ASSESSING STUDENTS' COMMUNICATIVE COMPETENCE IN A ROBOTICS-BASED VIRTUAL LEARNING ENVIRONMENT: CRITERIA, INDICATORS AND AN ANALYTIC RUBRIC

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Abstract. *Developing students' communicative competence is widely declared as a goal of technology-rich learning environments, yet it is rarely assessed in a valid and transparent way. This paper proposes an assessment framework for communicative competence in a robotics-based virtual learning environment. The framework links four components of the competence (motivational, cognitive, activity-based and reflective) to observable indicators and to evidence generated on the platform: forum posts, technical manuals, peer code reviews, team discussions and project presentations. An analytic rubric with four performance levels and an integrated scoring procedure that triangulates teacher assessment, peer assessment, self-assessment and learning analytics are presented. The framework is intended to make communicative outcomes of robotics courses visible, comparable and suitable for formative feedback.*

Keywords: *communicative competence, educational robotics, virtual learning environment, assessment criteria, analytic rubric, peer assessment, learning analytics, formative assessment.*

1. Introduction

Educational robotics has become a recognised vehicle for teaching engineering, programming and mathematics through hands-on projects. Because robots are usually designed and programmed in teams, robotics courses are also expected to develop students' ability to argue for technical decisions, document their work, give and receive feedback and present results. In Uzbekistan, this expectation is reinforced by the Concept for the Development of Higher Education until 2030, which calls for the wider use of modern pedagogical and information technologies and for strengthening students' practical and independent work [1].

A persistent difficulty, however, lies not in teaching but in assessment. Conventional tests in robotics courses measure technical knowledge and the functioning of the final robot, while the communicative side of the learning process remains largely invisible.

When communication is assessed at all, judgements tend to be holistic and intuitive, which limits their reliability and their value as feedback. Virtual learning platforms change this situation: much of students' interaction is recorded in written and multimedia form and can therefore be collected, analysed and assessed systematically.

The aim of this paper is to design an assessment framework for students' communicative competence in a robotics-based virtual learning environment, comprising criteria, observable indicators, sources of evidence, an analytic rubric and an integrated scoring procedure.

2. Theoretical background

The concept of communicative competence, introduced by D. Hymes, refers to the ability to use language appropriately in a particular social context rather than merely to know its system [2]. In professional settings this ability is realised through interpersonal and task-oriented behaviour, which B.H. Spitzberg argues should be assessed through multiple methods and observers rather than a single instrument [3].

The framework draws on three strands of assessment research. First, the principle of constructive alignment requires that intended outcomes, learning activities and assessment tasks be consistent with one another [4]: if a course intends to develop communication, the assessment must capture communicative performance. Second, research on formative assessment shows that assessment improves learning when it provides timely, specific feedback that students can act on [5; 6]. Third, scoring rubrics increase the reliability of judgements about complex performances and, when shared with students in advance, support self-regulation [7; 8; 9].

Peer assessment is particularly relevant to collaborative engineering work. K. Topping's review indicates that peer assessment in higher education can achieve acceptable reliability and benefits both assessors and assessees, provided that criteria are explicit and students are trained [10]. Finally, learning analytics makes it possible to use data generated by students' online activity to monitor and support learning [11]. In a virtual robotics environment, such data include the frequency and content of forum posts, participation in team rooms and the quality of peer comments.

3. Assessment framework

The framework treats communicative competence as a system of four interrelated components. For each component, criteria were formulated, and observable indicators and sources of evidence available on the virtual platform were identified (Table 1).

Table 1. Components, criteria, indicators and sources of evidence

Component	Criterion	Observable indicators	Source of evidence
Motivational	Readiness to communicate and collaborate	Initiates discussion threads; responds to peers voluntarily; participates regularly in team activities	Platform analytics; teacher observation

Component	Criterion	Observable indicators	Source of evidence
Cognitive	Command of professional terminology and communication norms	Uses technical terms accurately; follows the conventions of technical genres (manual, report, review)	Glossary tasks; tests; technical texts
Activity-based	Argumentation, technical writing, teamwork and presentation	Justifies design decisions with evidence; writes clear instructions; negotiates roles; presents and defends a project	Technical manual; team room records; recorded presentation
Reflective	Analysis of one's own and others' communication; constructive feedback	Gives specific, actionable peer comments; responds to criticism constructively; identifies own communicative difficulties	Peer code reviews; reflective journal; self-assessment

The indicators were chosen so that each one can be observed in an artefact or record produced during ordinary course activities. This keeps the assessment embedded in learning rather than added as a separate examination, and it allows the same evidence to serve both formative and summative purposes.

4. Analytic rubric

For the activity-based and reflective components, which cannot be measured adequately by tests, an analytic rubric with four performance levels was developed (Table 2). Each criterion is scored from 1 (beginning) to 4 (advanced). The rubric is published on the platform at the start of the course so that students can use it to plan and evaluate their own work.

Table 2. Analytic rubric for the activity-based and reflective components

Criterion	1 - Beginning	2 - Developing	3 - Proficient	4 - Advanced
Argumentation of design decisions	States a decision without justification	Gives a reason that is general or not linked to the task	Justifies the decision with relevant technical reasons	Compares alternatives and justifies the choice with evidence from testing

Criterion	1 - Beginning	2 - Developing	3 - Proficient	4 - Advanced
Technical writing	Text is incomplete; steps cannot be followed	Steps are present but unclear or out of order	Text is clear, ordered and uses correct terminology	Text is precise, concise and anticipates likely user errors
Peer code review	Comments are absent or purely evaluative (“good”, “wrong”)	Identifies problems without explanation	Explains problems and suggests corrections	Gives specific, prioritised and respectful suggestions that improve the code
Teamwork and negotiation	Works in isolation; avoids discussion	Participates when asked; rarely contributes ideas	Contributes ideas, listens to others and fulfils the assigned role	Facilitates agreement, resolves disagreements and supports teammates
Presentation and defence	Reads from notes; cannot answer questions	Presents the result but explains it superficially	Presents logically and answers most questions confidently	Adapts to the audience, uses visual evidence and handles critical questions convincingly

The descriptors are deliberately behavioural rather than evaluative: instead of “good argumentation”, they describe what a student actually does at each level. This reduces disagreement between assessors and turns the rubric into a guide for improvement, because each level shows the next step a student can take.

5. Integrated scoring procedure

To increase validity and reduce the subjectivity of any single judgement, the framework triangulates four sources of evidence: teacher assessment with the rubric, peer assessment, self-assessment and platform analytics. Each component score is first converted to a 100-point scale, and an integrated index of communicative competence is then calculated as a weighted sum:

$$I = w_1 \cdot T + w_2 \cdot P + w_3 \cdot S + w_4 \cdot A, \quad w_1 + w_2 + w_3 + w_4 = 1,$$

where T, P, S and A are the scores obtained from teacher, peer, self-assessment and learning analytics, respectively. The weights are determined by expert judgement; as a starting point, it is recommended that teacher assessment carry the greatest weight and that self-assessment carry the smallest, since self-ratings tend to be less reliable. Analytics should be used mainly to confirm participation and to flag students who need support, not as a direct measure of communicative quality.

On the basis of the integrated index, three levels of communicative competence are distinguished: high (80–100), medium (55–79) and low (below 55). The platform displays each student's results as a competence profile across the four components, which allows the teacher to give targeted feedback and the student to see which aspect of communication requires attention.

Several conditions are essential for the procedure to work. Students should be trained to use the rubric through calibration exercises on sample work before peer assessment begins [10]. Peer assessment should be anonymous where possible to reduce social pressure. Finally, assessment results should be returned with comments during the course, not only at its end, so that they can influence learning [6].

6. Conclusion

The proposed framework makes the communicative outcomes of robotics courses explicit and measurable. By linking the four components of communicative competence to indicators that are observable in artefacts produced on a virtual learning platform, it aligns assessment with collaborative learning activities. The analytic rubric provides transparent behavioural descriptors for the components that tests cannot capture, and the integrated scoring procedure combines teacher, peer, self-assessment and learning analytics to produce a more reliable and informative result. The framework can be adapted to other project-based STEAM courses delivered in virtual environments. Further research should establish the inter-rater reliability of the rubric and empirically validate the weighting of evidence sources.

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