

Advancing the Oral and Written Technical Communication Skills of Future Road Engineers Through Digital Technologies

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Abstract

The professional competence of future road engineers depends not only on technical knowledge but also on their ability to explain engineering problems orally, prepare accurate written documents, and communicate decisions to colleagues, contractors, public authorities, and road users. This article proposes a methodological framework for developing these oral and written technical communication skills through digital tools. The framework integrates learning management systems, collaborative documents, discussion forums, mobile field-data applications, audio-video submissions, electronic portfolios, and rubric-based feedback with authentic road-engineering tasks. The proposed process includes baseline diagnosis, modelling of professional examples, structured digital practice, formative feedback, revision, and evaluation. Five competency dimensions are identified: technical oral explanation, professional technical writing, collaborative communication, digital professionalism, and audience awareness. Sample activities and assessment indicators are provided for road-defect inspection, traffic-safety proposals, site-team coordination, and public-facing explanations. As no new participant dataset or measured intervention results were supplied for this article, the framework is presented as a design-oriented methodological proposal rather than as proof of experimental effectiveness. The article concludes with implementation recommendations and directions for empirical validation.

Keywords: Future road engineers; technical communication; oral communication; professional writing; digital tools; engineering education; formative assessment; road engineering.

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1. Introduction

Road engineering involves decisions that must be communicated precisely and responsibly. A road engineer may need to describe pavement deterioration, explain the technical basis of a maintenance recommendation, present a traffic-safety proposal, document a site inspection, coordinate contractors, or respond to questions from residents. These professional situations require the ability to speak clearly, write

logically, select accurate terminology, support claims with evidence, and adapt explanations to different audiences. Technical competence therefore includes the communication of engineering knowledge, not only its acquisition. The growing use of digital technologies has changed how engineering students access learning materials, work collaboratively, record observations, submit assignments, and receive feedback. Learning management systems (LMSs), shared documents, mobile applications, online meetings, audio-video recordings,

and electronic portfolios can provide repeated opportunities to practise professional communication. Yet the presence of technology does not automatically improve learning. Digital activities must be designed around specific communication outcomes and meaningful road-engineering tasks. For example, students can annotate a photograph of a road defect, produce a short written diagnosis, record an oral explanation, and respond to peer questions in an online forum. They can collaboratively compare traffic-management alternatives, document their decision in a technical memo, and present the recommendation to a simulated public audience. Such tasks connect oral and written communication with the disciplinary knowledge students are expected to use as future engineers.

The purpose of this article is to propose a practical methodological framework for developing future road engineers' oral and written technical communication skills through digital tools. It addresses four questions: (1) which communication competencies should be developed; (2) how can digital tools support authentic and repeated practice; (3) how can progress be assessed transparently; and (4) what conditions are required for implementation and future evaluation? The contribution is an integrated model linking competencies, digital functions, road-engineering tasks, assessment evidence, and a cycle of feedback and revision.

2. Literature Review and Conceptual Background

Engineering communication combines oral explanation, technical writing, interpersonal interaction, visual representation, and digital collaboration. Professional engineers must explain evidence to specialist audiences while also making technical implications understandable to non-specialists. In road engineering, communication products may include inspection reports, site records, risk assessments, design presentations, maintenance recommendations, meeting minutes, and public notices. These products are most effectively developed when communication is embedded in disciplinary work rather than isolated from technical learning. Active learning approaches emphasise student participation in meaningful tasks, problem solving, and application of concepts (Prince, 2004). Collaborative digital workspaces can make group contributions visible and

support joint drafting, while discussion forums provide time for students to formulate arguments and respond to alternative views. Audio and video recordings allow learners to rehearse explanations, observe their own performance, and compare it with explicit criteria. Electronic portfolios can preserve drafts and revised products, making development over time more visible. Formative assessment is important because students need actionable information about what is effective and what should be improved. Nicol and Macfarlane-Dick (2006) highlight the relationship between feedback, self-regulated learning, and students' ability to monitor their own work. In the proposed framework, feedback is therefore not a final comment added after assessment; it is a planned stage that leads to revision. Digital tools can support this process, but the quality of learning depends on the alignment between the task, the competency being targeted, the feedback, and the assessment criteria. Technology should be selected according to its educational function and local accessibility. UNESCO's Global Education Monitoring Report (2023) cautions that the value of educational technology depends on context, equity, and appropriate implementation. For this reason, the framework does not require a particular commercial platform. Institutions may combine an LMS with widely available shared documents, mobile devices, video-conferencing tools, and feedback forms, subject to institutional data-protection rules.

3. Research Design and Methodological Framework

This article uses a design-oriented methodological approach. It translates the identified educational need into an implementation framework that specifies target competencies, digital learning functions, authentic activities, assessment evidence, and a continuous improvement cycle. The article does not report a new controlled experiment, and no participant-level data, pre-test/post-test scores, or statistical outputs were supplied. Accordingly, the tables and figures below describe a proposed model and recommended indicators; they should not be interpreted as measured outcomes. The framework operationalises communication skills through five observable dimensions. The dimensions can be adapted to course learning outcomes and institutional assessment regulations.

Competency dimension	Observable performance	Example evidence
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Technical oral communication	Explains a road-engineering problem in a logical sequence, uses terminology accurately, and answers relevant questions.	Recorded briefing; live presentation; oral defence.
Professional technical writing	Produces structured, concise, evidence-based reports, memos, inspection notes, and professional emails.	Road-inspection report; technical memo; recommendation.
Collaborative communication	Shares responsibilities, listens actively, responds constructively, and documents decisions made by a team.	Discussion log; shared report; peer-review record.
Digital professionalism	Uses appropriate digital formats, communicates respectfully online, attributes sources, and handles field information responsibly.	Forum post; version history; online meeting notes.
Audience awareness and feedback literacy	Adjusts the explanation for technical and non-technical audiences and applies feedback to improve a product.	Two versions of a briefing; revised report; reflection.

The digital environment should support a connected sequence rather than a collection of unrelated applications. The minimum functions are distribution of

learning materials, communication and discussion, collaborative production, capture of oral performance, feedback, and storage of learning evidence.

Digital function	Pedagogical use	Road-engineering example
LMS course space	Organises learning materials, task instructions, deadlines, submissions, and progress records.	Provide a road-safety case, terminology list, and inspection-report template.
Discussion forum or chat	Supports written argument, questioning, and professional online etiquette.	Discuss alternatives for improving a hazardous junction.
Shared document or project board	Enables co-authoring, role allocation, and tracking of decisions.	Prepare a group road-inspection report with assigned responsibilities.
Mobile photo or field-data tool	Connects observation with precise description and evidence-based reasoning.	Annotate a pavement defect photograph and describe its likely implications.
Audio/video submission	Supports oral rehearsal, presentation practice, and self-review.	Record a two-minute explanation of a proposed traffic-management measure.
E-portfolio and rubric	Collects evidence over time and supports transparent assessment.	Compare the first and revised versions of a technical report.

The framework is organised into five connected stages. The stages should be repeated with progressively more

complex professional scenarios.

Stage	Instructor action	Student action	Evidence collected
1. Diagnose	Set a short oral explanation and written technical task; explain the rubric.	Complete an initial report or recorded explanation.	Baseline rubric scores and learner reflection.

2. Model and prepare	Provide examples, technical vocabulary, and criteria for quality.	Analyse a model report or video and identify effective features.	Annotated example; checklist; short quiz.
3. Practise digitally	Assign individual and group tasks through the LMS and shared workspace.	Discuss, draft, present, question, and document decisions.	Forum posts; shared-document history; recordings.
4. Feedback and revision	Give criterion-based feedback and facilitate peer review.	Revise work and explain which feedback was applied.	Draft/final comparison and reflection.
5. Evaluate and reflect	Use the same rubric to assess final performance and compare evidence over time.	Submit an e-portfolio and set improvement goals.	Final rubric scores, portfolio, self-assessment.

A shared rubric can improve transparency and help students understand what successful communication looks like. A five-level scale is proposed: 1 = beginning;

2 = developing; 3 = competent; 4 = proficient; 5 = advanced. The rubric should be shared before each task

Criterion	What is assessed	Suggested weight
Technical accuracy and terminology	Correct use of road-engineering concepts, terminology, and supporting evidence.	25%
Clarity and structure	Logical sequence, concise wording, signposting, and understandable conclusions.	20%
Audience and purpose	Appropriate level of detail and tone for the intended professional or public audience.	15%
Interaction and teamwork	Listening, relevant responses, respectful disagreement, and contribution to shared work.	20%
Digital professionalism and revision	Appropriate tool use, source attribution, responsible data handling, and application of feedback.	20%
Total		100%

4. Results

The main output of the design process is an integrated cycle connecting digital tools with authentic communication practice. Figure 1 shows the relationship between digital learning functions, road-engineering

activities, oral and written communication, and feedback. The platform is an enabling environment rather than the learning outcome itself. Development is expected to depend on repeated professional tasks, specific criteria, and opportunities to revise work.

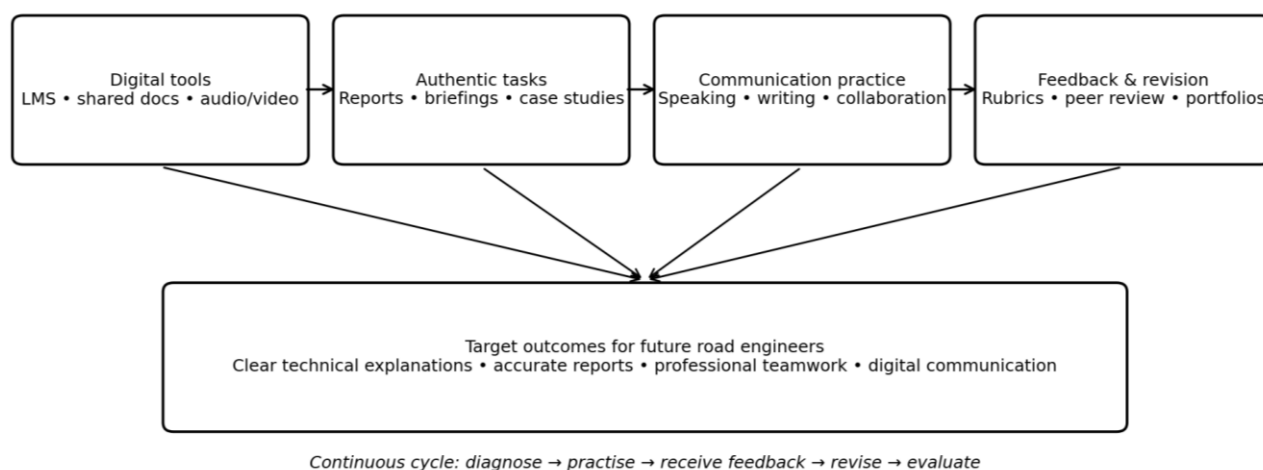


Figure 1. Proposed framework for developing technical communication skills through digital tools.

Figure 2 presents the iterative learning cycle. Initial diagnosis identifies students' starting points; modelling makes professional expectations explicit; digital practice generates communication products; feedback identifies

specific improvements; and revision provides evidence of learning. The cycle should be repeated rather than treated as a one-off intervention.

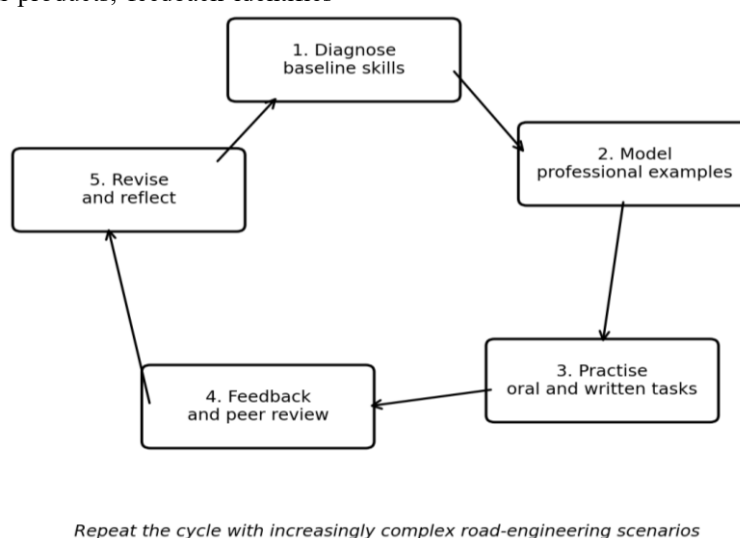


Figure 2. Repeated cycle of diagnosis, practice, feedback, revision, and reflection.

Table 4 provides example activities that can be integrated into courses in road engineering, traffic management, road construction, and transport infrastructure. These are

proposed activities, not claims that each activity has already been experimentally validated.

Task	Platform-mediated activity	Communication product	Assessment focus
Road-defect case	Students annotate a field photograph and discuss possible causes in a forum.	Defect description and short technical recommendation.	Accuracy, clarity, use of evidence.
Traffic-safety proposal	Teams compare alternatives in a shared workspace and document a decision.	Two-minute video pitch and one-page memo.	Argument quality and audience awareness.

Site-team coordination	Students role-play engineer, contractor, and local authority in an online meeting.	Meeting minutes and action register.	Listening, turn-taking, negotiation.
Public-facing explanation	Students rewrite a technical finding for a community audience.	Plain-language notice or infographic script.	Accessibility, tone, concise explanation.
Peer review and revision	Students review a peer's report using the rubric and revise their own work.	Annotated draft, final report, and reflection.	Feedback literacy and revision quality.

A simple course dashboard can help instructors adjust teaching in response to evidence. The indicators below are recommendations; no numerical values are assigned

because platform analytics and student assessment data were not supplied.

Indicator	How to calculate or observe it	Review frequency	Decision supported
Task completion	Completed submissions $\div$ expected submissions $\times 100$.	Weekly	Identify students who need support.
Technical writing quality	Mean rubric score for clarity, structure, terminology, and evidence.	Each major task	Plan targeted writing workshops.
Oral explanation quality	Rubric score for accuracy, organisation, pace, and response to questions.	Each oral task	Provide rehearsal and presentation support.
Interaction quality	Rubric score for relevant responses, respectful discussion, and contribution.	Every group task	Improve prompts and group roles.
Revision uptake	Number of applicable feedback points addressed in the final version.	Each revised task	Strengthen formative feedback.
Portfolio progression	Change between early and later rubric-scored products.	Midpoint and end of course	Evaluate development across the course.

The dashboard is useful only when evidence leads to instructional decisions. For example, frequent task completion alongside weak technical explanations may indicate a need for model answers and vocabulary support. Strong individual reports but weak group outcomes may indicate that roles, communication protocols, or peer-feedback procedures require clarification.

5. Discussion

The proposed framework treats oral and written communication as professional capabilities developed through repeated engineering work. This is particularly relevant to road engineering because technical decisions must often be documented, justified, presented, and explained to people with different levels of technical knowledge. Digital platforms can make these products visible and revisable throughout the learning process.

The combination of individual artefacts and shared team products also allows instructors to assess both personal responsibility and collaborative performance.

A central strength of the framework is the connection between authentic tasks and explicit assessment criteria. Rather than assessing communication solely through one final presentation, instructors can examine inspection reports, field descriptions, recorded briefings, meeting minutes, collaborative proposals, peer comments, and reflections. The use of a common rubric can make expectations clearer and help students transfer feedback from one task to the next. This approach is consistent with formative assessment principles that position feedback as a resource for improvement rather than only a judgement of completed work. Several implementation challenges should be considered. Students may have unequal access to devices or stable internet connections; online participation may not fully represent live oral

interaction; group work can hide unequal contributions; and platform analytics may measure activity rather than learning quality. These risks can be reduced through low-bandwidth alternatives, offline options, explicit group roles, individual reflections, transparent rubrics, and instructor review of actual communication products. Students should also be taught to attribute sources, protect personal and field data, and use AI-supported writing tools transparently according to institutional policy.

The framework has important limitations. It is a methodological proposal, not a report of a newly conducted experiment. No sample size, intervention duration, baseline scores, post-test scores, reliability estimates, or statistical analyses were supplied for this article. Therefore, no numerical learning gain or causal effect is claimed. Empirical research should test the framework using a clearly described intervention, comparable assessment procedures, and transparent reporting of quantitative and qualitative evidence. Future studies should report the number and characteristics of participants, task frequency and duration, platform functions used, instructor preparation, assessment-rubric reliability, baseline equivalence, missing-data handling, effect sizes, and uncertainty intervals. Interviews or student reflections could help explain which digital activities are perceived as most useful and whether improvements transfer to internships and workplace communication.

6. Conclusion

Digital tools can support the development of future road engineers' oral and written technical communication skills when they are integrated with authentic, discipline-specific tasks and combined with collaboration, formative feedback, revision, and transparent assessment. The proposed framework links digital functions to five competencies: technical oral communication, professional technical writing, collaborative communication, digital professionalism, and audience awareness with feedback literacy. Its implementation cycle—diagnose, model, practise, provide feedback, revise, and evaluate—offers a practical structure for courses in road engineering and transport infrastructure.

The main recommendation for higher education institutions is to assess communication through repeated professional artefacts rather than relying on a single final presentation. Technical reports, field observations,

collaborative proposals, recorded briefings, peer feedback, and e-portfolios can provide a coherent evidence base for student development. The framework should be adapted to local resources and validated through empirical research that reports its methods and outcomes transparently.

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