

Students' Solution Routines in a Nonstandard Problem on the Existence and Uniqueness Theorem for First Order Linear Differential Equations

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University training of modern engineers should prepare them for the solution of applied problems, many of which are described by differential equations (DEs). Recent shift towards computer-led solution of engineering problems undermines the role of advanced mathematical thinking in the education of future engineers negatively affecting their conceptual understanding of mathematical subjects, including DEs. Teaching and learning of DEs at the university level is a relatively new area of education research. Recent empirical studies indicate that students tend to concentrate attention on specific solution techniques and “often fail to relate them to other concepts or ideas” (Camacho-Machín et al., 2012, p. 76).

We continue the research in (Rogovchenko & Rogovchenko, 2022; Rogovchenko et al., 2020; Treffert-Thomas et al., 2018) analyzing the work of students in mechatronics in their fourth year of studies on a set of non-routine problems on Existence and Uniqueness Theorems for linear DEs. For a graded assignment, we designed “tasks and projects that stimulate to ask questions, pose problems, and set goals” whereas students “must learn to inquire systematically” and “must actively construct their own knowledge” (Richards, 1991, p. 38). The data include students' written work (three scripts), answers to pre- and post-questionnaires, and transcribed audio recordings of small group discussions and class presentations.

We analyze the development of students' discourse in one of the assessment problems using the constructs of narrative and routine from the commognitive theory (Sfard, 2008). Mathematical narratives are endorsed with the help of routines. The routine is performed by a person P in a task-situation TS and consists of a pair task-procedure. The same procedure may become a basis for different types of routines, depending on the performer's vision of the task. Expert participants of mathematical discourse interpret most task-situations as requiring a (re)formulation and endorsement of a particular type of mathematical narrative. Such outcome-oriented routines can be called explorations (Lavie et al., 2018). Solution routines were coded, and students' scripts were classified. Based on the data analysis we conclude that the students were able to participate in an explorative routine and produce solution procedures depending on their vision of the task.

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