

Reconceptualizing Teacher-Facing Learning Analytics as Experiencing the Educational Data Cycle in Teacher Education

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Abstract: Learning Analytics (LA) has been positioned as an infrastructure for data-informed educational improvement. However, in teacher-facing contexts, the availability of dashboards and analytics systems does not necessarily translate into teachers' instructional judgment or practical action. This challenge has often been discussed in terms of teachers' data literacy or interface usability, but this paper advances a different account. We argue that stagnation in Teacher-Facing Learning Analytics (TFLA) stems from limited opportunities for teachers to experience, articulate, and discuss the educational data cycle—the connected chain of data generation, representation, interpretation, and action—as a coherent structure grounded in pedagogical questions. From this perspective, we define educational data cycle experience (EDC experience) as opportunities that enable teachers to experience the educational data cycle in relation to pedagogical questions and to articulate and discuss it, and we propose EDC experience as a framing for teacher education. To operationalize this proposal, we present a pilot implementation embedded in a teacher education program, developed in collaboration with the National Institute of Informatics (NII), using a three-layer infrastructure comprising data generation (LMS), representation (dashboard), and interpretation (Python environment). Observations of selected reflective writings suggest that the phases emphasized in the pilot elicited distinct pedagogical questions—what to collect, how to operationalize indicators, and how to interpret under uncertainty—while some reflections also anticipated possible instructional responses. These observations suggest that the central challenge of TFLA lies less in indicator presentation than in how teacher education can design and provide EDC experience.

Keywords: Teacher-Facing Learning Analytics, Educational Data Cycle Experience, Teacher Education, Learning Analytics Infrastructure

1. Introduction

Learning Analytics (LA) has been positioned as an infrastructure for making learning processes visible and supporting evidence-informed instructional improvement. In teacher-facing contexts, however, the availability of analytics environments and dashboards does not in itself guarantee that teachers can connect indicators to instructional judgment or practical action (van Leeuwen, Teasley, & Wise, 2022). This challenge has often been approached in terms of dashboard design and data literacy (Schwendimann et al., 2017). However, such explanations remain insufficient when teachers can read indicators yet still struggle to determine what those indicators mean instructionally.

This paper approaches that challenge as a problem of experience. At the K-12 level, digital infrastructures that support classroom management, assignment distribution,

submission tracking, and grading are increasingly in use. More broadly, connecting assessment-related information to instructional improvement has long been recognized as an important educational challenge (Black & Wiliam, 1998). Yet the data produced in such environments are not necessarily experienced as data for instructional improvement. How to design opportunities for teachers to view educational activity as a site of data generation and to connect such data to instructional improvement therefore remains an important challenge for teacher education.

From this perspective, we reconceptualize Teacher-Facing Learning Analytics (TFLA) as a teacher-education design challenge. We define educational data cycle experience (EDC experience) as opportunities for teachers to experience, articulate, and discuss the connected chain of data generation, representation, interpretation, and action in relation to pedagogical questions. To operationalize this idea, we implemented a pilot in a professional graduate school of teacher education using a learning analytics environment experimentally provided by the National Institute of Informatics (NII).

In this paper, we conceptualize the educational data cycle as a four-phase chain consisting of generation, representation, interpretation, and action. However, the pilot reported here focused pedagogically on the first three phases. Action is retained as a necessary phase of the broader cycle, but in the present paper it is treated as part of the conceptual scope rather than as a direct object of analysis.

This paper addresses the following two questions:

RQ1. What kinds of pedagogical questions were articulated by participants at different phases of the educational data cycle?

RQ2. What do these reflections suggest about how relationships among the phases became discussable in teacher education?

2. Conceptual Framework: Experiencing the Educational Data Cycle

Our argument builds on prior work showing that learning analytics use involves more than reading indicators. Teachers must interpret data in relation to instructional context and then connect those interpretations to feasible responses (van Leeuwen et al., 2022). Likewise, an actionable insight is not simply a property of an indicator itself; it depends on how data were generated, what assumptions shaped their operationalization, what uncertainty remains in interpretation, and what kinds of response are possible in context (Jørnø & Gynther, 2018). More broadly, learning analytics research has long emphasized the importance of understanding analytics in cyclical terms that include intervention and response (Clow, 2012).

From this perspective, stagnation in TFLA stems not only from tool limitations but also from the limited opportunities teachers have to trace how pedagogical questions travel across the cycle as a whole. We therefore define the educational data cycle in teacher-facing contexts as a connected chain of generation, representation, interpretation, and action.

By generation, we do not mean that data simply arise automatically. Rather, instructional and assessment design shape what kinds of learning data can be generated and captured. Representation refers to the construction of indicators and visual forms from raw learning records. Interpretation refers to making sense of those representations under contextual and evidential constraints. Action refers to the instructional responses or supports that may follow from such interpretations.

In this paper, EDC experience refers to opportunities to engage with these phases not as isolated technical operations, but as a pedagogically connected structure. This framing is also consistent with research suggesting that effective use of learning analytics depends not only on technical skill, but on its integration with pedagogy (Li, Jung, & Wise, 2025; Mishra & Koehler, 2006). The central issue, then, is not merely whether teachers can operate dashboards, but whether teacher education can make visible and discussable how data are generated, what indicators presuppose, and under what conditions interpretations can be made.

Figure 1 presents this broader four-phase model of the educational data cycle. The figure is not intended to imply that all four phases were equally enacted in the present pilot. Rather,

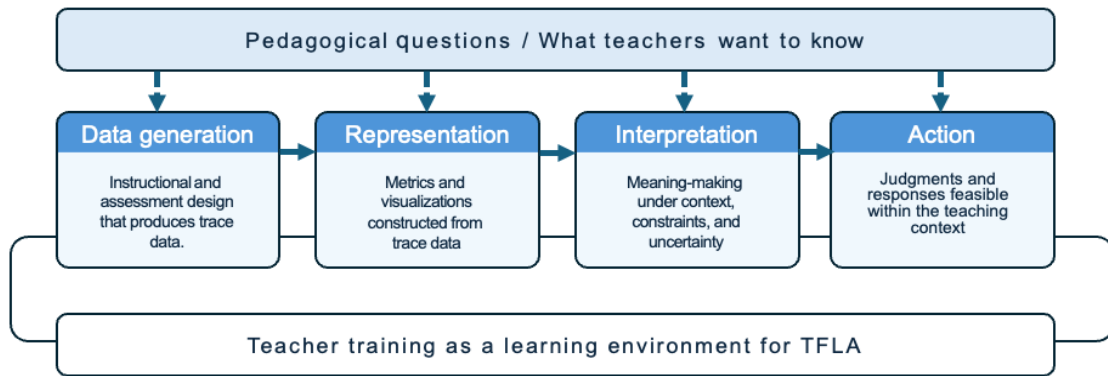


Figure 1. Conceptual model of experiencing the Educational Data Cycle

the pilot focused pedagogically on making the relationships among generation, representation, and interpretation explicit within teacher education.

3. Pilot Implementation and Exploratory Observations

The pilot was conducted with in-service teacher-students enrolled in a professional graduate school of teacher education in Japan, with up to 54 participants across sessions. The implementation used Moodle for instructional design and data generation, Superset for dashboard-based representation, and JupyterHub for exploratory interpretation, all connected through a shared learning record store. This environment was experimentally provided by the National Institute of Informatics (NII).

In this paper, post-session reflective writings are used as exploratory and illustrative material. The aim of the present paper is to offer an initial account of what kinds of questions emerged at different phases of the educational data cycle. Accordingly, rather than conducting a comprehensive qualitative analysis of the full dataset, we selectively draw on representative reflections that illustrate the characteristics of each phase. The analysis presented here should therefore be understood as an exploratory organization prior to more detailed qualitative analysis.

The design intentionally staged the first three phases of the educational data cycle. As a pre-task, participants experienced MEXCBT so that learning activity could first be encountered as a recordable trace. Session 1 focused on the generation phase through the design of instructional materials, questionnaires, and quizzes in Moodle. Session 2 focused on the representation phase through the construction of indicators and visualizations in Superset. Session 3 focused on the interpretation phase through exploratory analysis in Python on JupyterHub, including consideration of alternative explanations and the limits of inference.

Across the three sessions, participants articulated different kinds of questions. In the generation phase, reflections suggested growing awareness that what data can later be obtained depends on how activities and items are designed in advance. For example, one participant noted that “what can be understood depends on what items we set,” indicating recognition that instructional and assessment design also shapes the conditions of data capture.

In the representation phase, participants referred to visualization and indicator construction as being shaped by purpose and assumptions. One participant wrote that “data collection should not become the goal itself,” suggesting that representation was experienced in relation to educational purpose and context of use.

In the interpretation phase, reflections more often highlighted the difference between seeing data and reading them appropriately, as well as the uncertainty involved in interpretation. For example, one participant stated that “with limited data, it is difficult to make definitive claims,” indicating that interpretation was experienced as cautious judgment rather

than simple reading. At the same time, not all participants articulated relationships across phases equally explicitly, and hesitation was especially visible in the interpretation phase. This suggests that movement across the cycle was not self-evident.

Some reflections also referred to possible uses for lesson improvement or learner support. However, the present pilot did not examine enacted action or its effects. Such references are therefore more appropriately understood not as evidence of action itself, but as anticipations of possible response beyond interpretation.

Taken together, the selected reflections suggest that different pedagogical questions emerged at different phases of the educational data cycle. The generation phase foregrounded what can be made available as data, the representation phase foregrounded what should be represented and for what purpose, and the interpretation phase foregrounded how cautiously meaning can be constructed under uncertainty. These observations suggest that staging generation, representation, and interpretation in teacher education may help make their relationships more discussable. At the same time, the analysis offered here remains exploratory and illustrative rather than comprehensive.

4. Conclusion

This paper proposed EDC experience as a conceptual framing for understanding persistent challenges in TFLA. Rather than treating the issue only in terms of indicator presentation or tool use, we argued that an important task for teacher education is to enable teachers to experience, articulate, and discuss the broader chain linking pedagogical questions with data generation, representation, interpretation, and action.

Through a pilot in a Japanese professional graduate school of teacher education, we also offered an exploratory illustration of how staging the first three phases of the educational data cycle may help surface different pedagogical questions at each phase. The selected reflections illustrated awareness of data capture in the generation phase, the purposive nature of visualization in the representation phase, and the uncertainty and collaborative sensemaking involved in interpretation.

At the same time, the analysis presented here remains exploratory and illustrative. It does not provide a comprehensive qualitative analysis, nor does it empirically examine the action phase. Future work should therefore undertake a more systematic qualitative analysis of the full reflective dataset and examine how experiences of generation, representation, and interpretation connect to action in authentic educational settings.

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