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A Taxonomy for Teacher-Actionable Insights in Learning Analytics

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Abstract: In the field of learning analytics (LA), actionable insight from LA designs tends to be a buzzword without clear understandings. As the teacher is a key stakeholder, what teacher-actionable insights can be derived from LA designs? Towards providing greater clarity on this issue, we concretize a taxonomy of LA decision support for teacher-actionable insights in student engagement. Four types of decision support are conceived in this taxonomy with relevant teacher implications. Through this taxonomy, we hope to offer possible pathways for actionable insight in LA designs and make clearer the role of the teacher.

Keywords: Learning analytics, teacher, design, taxonomy, actionable insight

1. Introduction

In the field of data analytics, the term "actionable insight" is a buzzword without clear definitions. Recognizing this, Tan and Chan (2015) provide a three-tiered definition for actionable insights in data analytics systems: analytic insight (understanding and inferring individual information), synergistic insight (contextualizing, combining and linking information), and prognostic insight (deriving information of future results). Similarly, others have highlighted an analytics continuum ranging from descriptive, diagnostic, to predictive and prescriptive analytics (Gartner.com). In the field of Learning Analytics (LA), concomitantly, several conceptions and understandings of actionable insight exist from different stakeholders such as learners and teachers (Lu, Huang, Huang, & Yang, 2017; Sergis & Sampson, 2017). Evident from extant literature is that "insight" can be understood in several ways and from different stakeholders. Many LA designs have focused on providing interventions such as tasks and recommendations for the learner. However, comparably less attention is paid to a closely intertwined stakeholder, the teacher (Sergis & Sampson, 2017). Especially within the K-12 education context, where the teacher more often than not plays a crucial 'make-or-break' role in the learning and teaching process (Hattie, Masters, & Birch, 2015), teacher-actionable insights are important.

What teacher-actionable insights can be derived from LA systems? Towards scoping this question, we premise the design of many LA systems in the area of engagement in learning. In the pedagogical core of learning there is an interaction between learners and the content, as well as between peer learners (Tan & Koh, 2017). Hence, student engagement is commonly measured in LA designs and used to inform actionable insight such as through the engagement of students with the content, and with other peers (Lu et al., 2017; Tan & Koh, 2017).

We posit that LA can provide teacher-actionable insights for understanding this engagement in learning. As such, we conceptualize a taxonomy of LA decision support for teacher-actionable insights in student engagement. This taxonomy is briefly illustrated using the Collaborative Video Annotation and LA (CoVAA) Learning Environment, a prototype LA time-point based video annotation system.

2. Conceptualizing a Taxonomy for Teacher-Actionable Insights in LA Designs

Informed by the literature, we conceptualize four types of LA decision support for teacher-actionable insights in student engagement: *descriptive, diagnostic, predictive* and *prescriptive* (Table 1). The second column in Table 1 describes the areas of teacher-actionable insight, which is a more macro view

of system feedback to the teacher. The third column highlights certain data science methodologies and techniques required while the last column provides implications of this decision support for teachers.

Table 1: A taxonomy of LA decision support for teacher-actionable insights in student engagement

Type of LA decision support	Areas of teacher-actionable insights	Possible data science methodologies	Implications for teachers
Descriptive	What are students engaged in? What are they doing, feeling, learning?	Dashboard summaries, visualizations, descriptive statistics	Broad ranging areas of action, relies on the agency of teachers
Diagnostic	Why are students' engaged?	Visualizations, process mining, drill-down tools, correlations, data discovery, and data mining	More specific areas of action, but still requires teacher discernment for intervention
Predictive	What will students' be engaged in? Which groups of students' will be engaged?	Machine learning, regression analysis	Relieves load of teachers for certain areas of action, but could provide other opportunities for teachers to look at other areas of engagement
Prescriptive	What can be done to engage students?	Machine learning, algorithms, predefined conditions	

2.1 Descriptive

Descriptive analytics describes what students' activities on the system are, depicting indicators of student engagement for the teacher. It represents the foundational data structures in LA and describes what students' activities on the system are. For instance, in CoVAA, teachers are able to download a set of participation data including annotation type, critical lens tag, and comment description, which makes it convenient for them to examine and provide feedback on students' answers. Many LA designs provide such engagement data in real-time so teachers are able to see and monitor the activities of students instantaneously. Descriptive analytics typically summarize different engagement types for teachers using descriptive statistics in graphs etc. Still challenges of what metrics to measure as learning designs become more sophisticated and how best to represent them exist.

Teacher-actionable insight at this layer tends to directly relate to the metric or indicator measured e.g., submission data. Besides giving the teacher an aggregated understanding of the students, and/or comparison of learners, the LA engine typically does not provide further decision support for the teacher. Teacher actionable insight depends on the capacity and agency of the teacher to take action. Teachers have to make sense of the data and decide for themselves appropriate interventions (Sergis & Sampson, 2017). In that sense, descriptive analytics offers broad ranging areas of teacher-actionable insights, but also relies on the capacity of teachers to decide and perform more targeted interventions.

2.2 Diagnostic

Diagnostic analytics tries to explain why students did what they did using data science methodologies and techniques including visualizations, process mining, correlations, data discovery, and data mining.

This LA design attempts to link relationships to explain student engagement and helps teachers to pinpoint specific areas for possible interventions. Still, teachers should be discerning and decide pedagogically if they should intervene. For CoVAA, this layer of diagnosis is currently done in the back-end using existing statistical techniques by researchers, and shared with the teachers, as data-driven evidence for teachers to take action.

2.3 Predictive and prescriptive

Predictive and prescriptive analytics are closely related. While predictive analytics provide empirical evidence of what students will be engaged in, prescriptive analytics provide recommendations to the student, reducing the immediate intervention required by the teacher. Predictive analytics provide empirical evidence of what students will be engaged in. This layer provides teachers with foresight, what will happen based on probability estimates. On the other hand, prescriptive analytics asks "what can be done to engage students" and prescribes actions that the system takes on behalf of the teacher. It computes activities and responses that the system can do now based on predefined conditions that were determined by diagnostic and predictive analyses.

Predictive analytics provides very clear and specific teacher-actionable insight. Decision support for the teacher is precise and could include filtering and identifying different clusters of students such as those potentially at risk from academic failure and dropout. It can also identify students who are potentially on an accelerated trajectory. Teachers' usage of system tools can also predict student achievement. Prescriptive analytics then seeks to identify specific sets of activities that students can take, without the immediate intervention from the teacher.

While on one hand these two types of support may seem to reduce the need for the teacher, we posit that at the same time, this provides opportunities for teachers to go beyond the common set of responses to probe deeper into student engagement or examine new trends among their students. Seemingly, this helps relieve the load of teachers' direct instruction to the student, and could help the teacher to focus on other areas of student engagement that is not provided for by the system. As such solutions require more time and testing, these analytics are part of the future work planned in CoVAA.

3. Concluding Remarks

We have conceptualized a taxonomy of LA decision support for teacher-actionable insights in student engagement comprising four types. While these types may seem to have some sort hierarchical relationship, e.g., each type being a more complex type of the other, we realize that each could uncover engagement ranging from the superficial, simple to complex and deep. Each type then offers various pathways of providing feedback to teachers. Teacher-actionable insights in student engagement is a crucial area for the emerging field of LA, and in clarifying possible pathways, LA designs can be made more useful for teaching and learning.

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