Pre-Service Teachers' Diagnostic Argumentation: What is the Role of Conceptual Knowledge and Epistemic Activities?

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Abstract: We analyze pre-service teachers' diagnostic argumentations in learning with simulated cases by exploring relations within and between the two dimensions of domain-specific conceptual knowledge and cross-domain epistemic activities. Using the method of ENA, we conclude that both dimensions are relevant in pre-service teachers' diagnostic argumentation and hence in designing learning interventions for its facilitation. The results also suggest that conceptual knowledge better explains differences between accurately vs. inaccurately diagnosing pre-service teachers compared to the dimension of epistemic activities.

Keywords: Teacher education, diagnosing, argumentation, epistemic activities.

Pre-service teachers' diagnostic reasoning and argumentation

Teachers need to assess students' progress and difficulties with respect to learning. However, teachers' reasoning is inaccurate in many cases (see Südkamp, Kaiser, & Möller, 2012). Typically, teacher education does not entail extensive training of teachers' diagnostic skills. Thus, teachers often have problems engaging in diagnostic skills like diagnostic argumentation. Previous research on diagnosing primarily supports the assumption of domain-specific conceptual knowledge as a prerequisites for diagnostic accuracy (Schmidt & Rikers, 2007). We suggest addressing another dimension of diagnostic skills as well: Cross-domain applicable epistemic activities, e.g. generating hypotheses, generating evidence, evaluating evidence and drawing conclusions, in which conceptual knowledge is applied to cases (Fischer et al., 2014). We assume that accurate and inaccurate reasoners might as well differ in terms of applied epistemic activities and in terms of the relation between conceptual knowledge and epistemic activities (Hetmanek, Engelmann, Opitz, & Fischer, 2018). Therefore, we investigate to what extent accurately vs. inaccurately diagnosing pre-service teachers' diagnostic argumentations differ with respect to the relations within and between the two dimensions of conceptual knowledge and epistemic activities.

Method

116 pre-service teachers participated in a study using a simulation-based learning environment presenting eight cases of students potentially having ADHD or dyslexia. We asked participants to indicate a diagnosis and write a justificatory argumentation for every case. In one of the cases, the secondary student Anna displays symptoms of an attention-deficit disorder. Participants could e.g. examine written observations of Anna's behavior, look at an annual report or read conversations with the parents and other teachers. We coded all written diagnoses as *accurate*, *partially accurate* and *inaccurate*. 12,5 percent was double coded resulting in an inter-rater reliability (IRR) of Cohen's κ = .80. Next, we coded the argumentations in two independent rounds of coding. IRRs of the epistemic activities *generating hypotheses, generating evidence, evaluating evidence* and *drawing conclusions* were at least satisfying (15 percent coded by four raters; overall IRR of Krippendorff's $α_U$ = .65; ranging from $α_U$ = .43 to $α_U$ = .75). In a second round, we double-coded 15 percent of the data regarding six case-specific conceptual categories: *inattentive, hyperactive-impulsive, cognitive, autistic, socio-emotional, and motivational* (IRRs ranging between Cohen's κ = .79 and perfect). We coded the remaining data automatically with the tool nCoder (IRRs between nCoder and the two raters were between Cohen's κ = .71 and perfect). We analyzed the 116 argumentations from the case Anna (see above) using Epistemic Network Analysis (Shaffer, 2017). The ENA algorithm operationalizes co-occurrences of codes by contextualizing each sentence within all previous sentences in the same argumentation. The algorithm aggregates co-occurrences and constructs a network model showing the connections between each pair of codes for single or for groups of argumentations. The resulting network graphs depict codes as grey nodes and the relative frequencies of their co-occurrences as colored edges.

Results

Figure 1 shows argumentation networks of accurately (a) vs. inaccurately (b) diagnosing pre-service teachers. The network of the accurate students (a) depicts an argumentation for the correct conclusion, which is represented by the edges relating the codes *evaluating evidence* and *inattentive* as well as *drawing conclusions* and *inattentive*. Still, accurate learners also partially consider other concepts like *socio-emotional* and *motivational* aspects. In contrast, the inaccurate pre-service teachers' network (b) depicts thicker edges between *evaluating evidence* and *generating evidence*, representing a higher emphasis on the dimension of epistemic activities within the diagnostic argumentations. Conceptually, the inaccurate pre-service teachers' network (b) also mostly reflects the conceptual categories *inattentive*, *socio-emotional* and *motivational*, but inaccurate pre-service teachers rather include other categories like *autistic* as well. These differences are particularly visible in the comparison graph (c) presenting only the group differences by subtracting the two groups' networks. Compared to accurate pre-service teachers, inaccurate pre-service teachers are rather distracted by evaluating less relevant conceptual categories and rather misinterpret the case information, e.g. referring to inadequately concepts (e.g. *autistic* in this case).
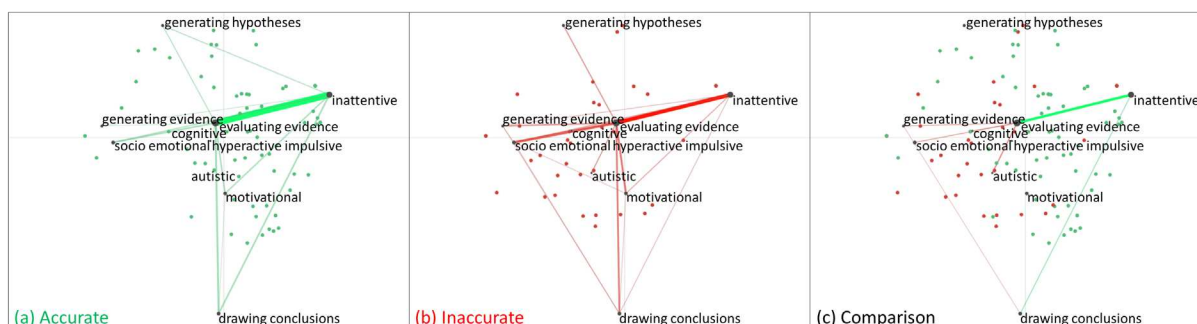

Figure 1. Networks of accurate (a) and inaccurate (b) diagnosing pre-service teachers. Comparison graph (c) showing the networks differences by subtracting them.

Discussion

The results support the theoretical assumption of domain-specific conceptual knowledge and cross-domain epistemic activities being relevant for pre-service teachers' diagnostic argumentation about students' behavioral and developmental disorders (see Fischer et al., 2014; Hetmanek et al., 2018). In the ENA networks, we see that accurately vs. inaccurately diagnosing pre-service teachers differ with respect to both dimensions, applied conceptual knowledge and epistemic activities; but the dimension of applied conceptual knowledge seems to be more critical in explaining the differences between the two groups. This corresponds to the theoretical notion of domain-specific conceptual knowledge being crucial for accurate reasoning and argumentation (Schmidt & Rikers, 2007). One limitation in interpreting the results is the rather low inter-rater reliability of the epistemic activity coding. It is possible that the coding induced too much unsystematic variance to the data to reveal interconnections and differences in this dimension reliably. With respect to teacher education, our findings offer initial evidence for providing opportunities to apply conceptual knowledge in epistemic activities, e.g. in simulated cases. With respect to research, we suggest experimental investigations into the issue of instructional support regarding the application of conceptual knowledge only or in combination with epistemic activities.

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