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Interaction-based coding of scaffolding processes

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ABSTRACT

In this article, we present a methodology for measuring scaffolding in small group classroom settings. We have investigated scaffolding by analysing teacher-student-interactions and developed an instrument to code *student level of attainment* and *teacher strength of intervention* as the relevant student and teacher variables. For the construction of interaction patterns the coded variables were related to each other. In order to assess the resulting interaction patterns for scaffolding quality, we devised rules based on the contingent shift principle. The analyses show that our methodology is reliable and valid, and that it is effective for discerning contingent from non-contingent interaction patterns. Furthermore, our fine-grained methodology allows us to identify and locate crucial points in the teacher's supporting behaviour that make for contingent or non-contingent scaffolding. Implications for the assessment of instructional quality as well as for teacher education and professionalism are discussed.

1. Introduction

1.1. Scaffolding and its measurement in formal education

In *Thought and Language*, Lev Vygotsky writes that "(a)ny thought has movement. It unfolds" (1987, p. 250). However, there are moments when such unfolding gets stuck. In those situations learners need support. The idea of teacher's support is closely connected to the notion of scaffolding, which in its original sense refers to a more capable person offering temporary support, helping learners to perform tasks that they could not (yet) complete by themselves (Wood, Bruner, & Ross, 1976; Wood, 1980; Maybin, Mercer, & Stierer, 1992; see Fernández, Wegerif, Mercer, & Rojas-Drummond, 2001). Thus, the teacher's intention should be to (gradually) lead learners to a state of competence in which they can master similar tasks independently (Greenfield, 1984; Tropper, Leiss, & Hänze, 2015; Van de Pol & Elbers, 2013). Whilst the general idea seems clear and undisputed, extracting scaffolding episodes and their dynamics from the overall stream of classroom interaction still appears to be difficult. Thus, the aim of our study is to develop a methodology for measuring scaffolding in teacher-student-interactions.

What are the characteristics of scaffolding in teacher-student-interactions? According to Vygotsky and the concept of the *zone of proximal development* (ZPD), scaffolding is closely related to constructivist theories. Likewise, it should not be conceived as merely targeted at outcomes. In fact, scaffolding focuses on the process of active knowledge construction. As a consequence, teachers need to adopt the learners' perspectives, diagnose their current level of understanding and, if required, get involved in their cognitive processes and co-constructive activity. Or, as Bruner (1978) puts it: the teacher should act as the student's "vicarious consciousness" (see Fernández et al., 2001). Hence, scaffolding encompasses two main characteristics:

Dynamic assessment: To ascertain the right amount of support and appropriate content, the teacher needs to find out about the current state of the student's understanding and knowledge construction. This requirement emphasises the importance of diagnostic activities before and in between interventions (Van de Pol, Volman, & Beishuizen, 2012; Pea, 2004).

Procedural facilitation — Intervening neither too strongly nor too weakly: As Reusser — relating to Cohen (1994) — suspects, there is always a risk that the teacher does too much of a good thing, i.e. restricting the students' autonomy and possibilities in deriving their own solution (Reusser, 2001). Wittwer and Renkl agree with Reusser that "instructional support should not replace learners' knowledge construction activities" (2008, p. 56). However,

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guidance cannot only be too much "hands on", but also too much "hands off". This is why Kirschner, Sweller, and Clark (2006) take the view that minimal guidance may often be insufficient and unsatisfactory for students and call for stronger instructional guidance.

According to these considerations, we may conclude that scaffolding

- applies to 'asymmetrical' interactions (support provided by a more capable person),
- means *temporal* support, to be removed when the learning difficulty has been overcome in order to restore the student's autonomy,
- concentrates on learners' cognitive processes, where the teacher's role is to provide "tailored" support, gradually leading the learner towards a higher level of understanding.

There are basically two approaches for the assessment of scaffolding in classrooms. One way is to examine scaffolding using global ratings of whole lessons (e.g. Kleickmann, Vehmeyer, & Möller, 2010). Global ratings are useful for an overall view of scaffolding quality. However, they do not inform us about the interaction dynamics, i.e. the adjustment of teachers' support to the individual needs of the learners.

The other approach attempts to meet this requirement and relies on analysing teacher-student-interactions (Van de Pol, 2012; Steenbeek, Jansen, & van Geert, 2012; Wischgoll, Pauli, & Reusser, 2015; Prediger & Pöhler, 2015). As scaffolding draws on constructivist learning theories, coding systems need to concentrate on knowledge construction and understanding. In practice, it means to measure how teachers help students "to move from one level of understanding to another" (Myhill & Warren, 2007, p. 68). Stone (1993) calls it the student's process of "appropriation of meaning" (p. 171). Likewise, teacher-student-interactions could be described as a co-evolution of student's levels of understanding and teacher's supporting behaviour. In sum, to measure scaffolding according to the second approach four components are important:

(i) a *student variable* capturing the current state of knowledge construction,
(ii) a *teacher variable* informing about the strength of intervention,
(iii) *criteria* for the conception of interaction patterns (by relating both variables to one another),
(iv) *coding rules* to judge the quality of interaction patterns (scaffolds).

1.2. Interaction-based measurement of scaffolding according to the contingent-shift principle

A rationale that emphasises the dynamic nature of scaffolding relies on the contingent-shift-principle (CSP). It was introduced by Wood, Wood, and Middleton (1978); see also (Wood, 1980). and matches the definition of scaffolding as "tailored support", since it addresses modifications in the teacher's behaviour according to the students' individual needs. CSP can be expressed as a rule: If a learner fails, increase control in a stepwise manner, until the learner succeeds; then decrease control. Support according to CSP was labelled "contingent" (or "non-contingent", respectively), and used as a cachet for scaffolding quality.

A methodology based on CSP was introduced by Van de Pol (2012). Her coding system is very promising as it allows to code patterns in a reliable way. We thus decided to use it as a reference for building our own coding system upon it. In a nutshell, her approach can be characterised as follows: (1) Units of analysis are composed of three-turn sequences (teacher – student – teacher). (2) The teacher variable consists of six levels representing degrees of control. (3) The student variable ("student understanding") comprises three categories: poor or no understanding, partial understanding, and good understanding. (4) Each of the three-turn sequences is finally rated as contingent or non-contingent according to CSP.

As already stated, this method yields reliable results. However, there are some aspects with respect to validity, which need to be addressed. First, cutting teacher-student-interactions into three-turn sequences seems too rigid and fails to do justice to the logic and complexity of such interactions. In fact, three-turn sequences are often too small to capture scaffolds in their entirety, because interaction dynamics of contingent scaffolding typically manifest in a gradual increase of support that entails longer time periods. Second, the variable "teacher degree of control" comprises three different scale criteria (new vs. no new content, elaborateness of response, openness of questions). It remains unclear, how these criteria are linked to each other. Third, the coding of "student understanding" is based on the information given in the third turn (teacher's response to the student's utterances).[1] Therefore, factual student understanding is not being measured but the teacher's judgement of the student understanding. Rather than coding teacher-student-interactions, the methodology relates teacher's diagnoses to his/her subsequent behaviour. This affects the validity of measurement and leads to a bias in favour of contingent patterns.

1.3. Study objectives

The objective of the present study is to develop a methodology that accounts for a valid measurement of scaffolding in teacher-student interactions. This methodology needs to be in line with CSP and to reveal how the teacher helps the students to move from one level of understanding to another. Thus, we need a student variable that reflects the process of knowledge construction and a teacher variable that measures the teacher's participation in this process (stepwise enhancement of support). We designed our instrument based on the four requirements (Section 1.1) and on van de Pol's coding system (according to the refinements suggested in Section 1.2).

We mainly attempt to achieve this aim by focussing on two major objectives:

- The first is to identify appropriate units of analysis to capture scaffolds as meaningful entities in teacher-student-interactions
- The second is to devise coding rules that allow us to distinguish between contingent and non-contingent scaffolds according to CSP.

The resulting interaction-based coding system would not only enable us to assess the scaffolding quality over whole lessons, but also to localise the teacher's supporting behaviour that causes this

[1] "Student understanding was coded according to the apparent judgment of the teacher in the interaction fragment. In other words, when a teacher approved of a student's answer, the answer was considered correct, but when a teacher disapproved or asked a follow-up question, the answer was, in turn, coded as poor understanding or partial understanding. […] The teacher decides, based upon *his* or *her* assessment of the students' understanding, the level of control that he/she will assert. Therefore, a use of a more objective criterion (e.g., based on the subject matter itself) could potentially result in conflicting decisions; we might judge a three-turn sequence to be noncontingent while the teacher is, according to his or her own judgment, being contingent. Therefore, we chose to adopt the teacher's perspective regarding contingency." (Van de Pol, 2012, p. 94).

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