# Back to the chalkboard: Lessons in scaffolding using SOLO taxonomy from school teachers for university educators

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*This paper has been developed from a practical oral presentation given by the author as a bursary winner at the second annual DART-P Conference which took place at the University of Cardiff in June 2019.* ***Objectives:*** *The aim of this paper is to share practical strategies for teaching techniques, that are common to the school classroom, adapted to the context of university education. Specifically, this paper will examine how lecture-based teaching can be differentiated for university students at different stages in their learning journeys in the same lecture hall.* ***Background:*** *There is a truism in educational circles that the older the individuals who teachers hope to educate, the less the availability of evidence-based pedagogical research to guide their teaching practice. It is widely accepted that despite the similarity in age between university students in the same cohort there are often stark differences in learner profiles. However, there is precious little training or research to inform university lecturers on how to differentiate their teaching to suit the level of a wide range of students.* ***Methods:*** *Four strategies for scaffolding and differentiation, originating from school-based pedagogy but adapted for the lecture theatre environment, will be presented with examples and modelling. Each strategy will be linked to the Structure of Observed Learning Outcome (Biggs & Collins, 1982) model.* ***Conclusions:*** *This paper will provide practical strategies for university lecturers and educators to test in their own practice to assist in ensuring that no student is left behind in their teaching.*

IT HAS BEEN well documented that the expansion in demand for higher education has been associated with increasing levels of diversity in the backgrounds of students accessing higher education (Arum et al. 2007; Finnegan, Merrill & Thunborg, 2014; Jury et al., 2017). This diversification of students accessing higher education is accompanied with profound benefits for society and higher education institutions. For example, higher levels of diversity in higher education cohorts appears to have a positive impact on the openness of students to new ideas and can be argued to foster cognitive development (Gurin et al., 2002; Harper & Yeung, 2013). However, there are also associated challenges for university educators in the increasing diversity of students in their lecture halls. For example, providing engaging and accessible educational experiences for diverse groups of students can pose challenges for educators that exceed those posed by more homogenous groups (David, 2008).

As educators, lecturers, in much the same manner as schoolteachers, have a responsibility to address the inequalities and diversity of learning needs of their students and this is where a consideration of differentiation becomes essential. Differentiation requires educators to be able to consistently and reliably identify differences in students learning outcomes and, on this basis, to target scaffolding strategies in such a way as to address these differences in learning outcomes. One framework which can provide a structure to both these critical components of differentiation is Structure of Learning Outcomes (SOLO) Taxonomy (Biggs & Collins, 1981).

## SOLO taxonomy

Frameworks such as SOLO taxonomy are vitally important for educations when considering work quality. While quantity of work,

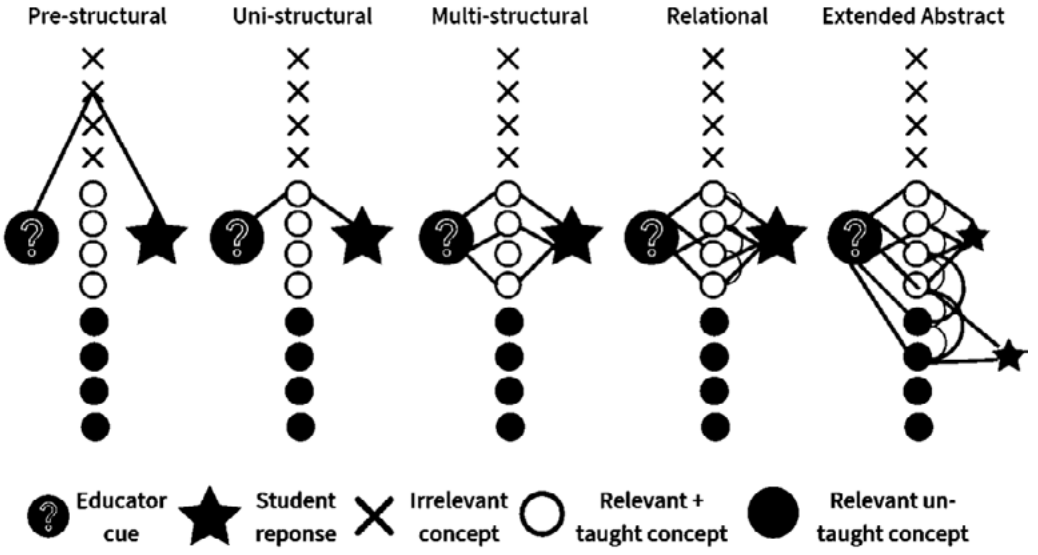
for example, the number of studies a student has included in an essay, is straightforward to measure, quality can be a highly illusive concept. SOLO taxonomy (Biggs & Collins, 1981) is a criterion-based framework which allows discrimination between learning of differing levels of maturity and complexity.

SOLO taxonomy provides an alternative framework to the more commonly utilised Bloom's Taxonomy (Bloom, 1956). While Bloom's Taxonomy is often useful when generating cues or questions for pupils to respond to of varying levels of difficulty, there are several limitations when it comes to its use for differentiation and consistent evaluation of learning outcomes. Firstly, Bloom's Taxonomy relies upon 'cue words' which are organised in a hierarchy which remains consistent regardless of learning task. This makes Bloom's Taxonomy rather inflexible as a system for assessment, as what a high-level learning outcome consists of is pre-determined, rather than a product of particular learning material provided. Secondly, Bloom's Taxonomy has several 'cue words' which are ambiguous in the level or complexity of work they describe. For example, the word 'discuss' could be used to refer to a relatively simple piece of work that describes in simplistic terms a concept or it may refer to a multi-faceted exploration of a concept (Stanny, 2016). Thankfully, SOLO taxonomy is able to address many of the downfalls of Bloom's Taxonomy and provides a more flexible and consistent framework for both scaffolding towards and assessment of learning outcomes.

SOLO taxonomy is structured as a five-level framework with each level representing a more mature level of learning outcome than the previous. The five levels are named: Pre-structural, uni-structural, multi-structural, relational and extended abstract. A comprehensive diagram is presented in Figure 1 which may be helpful to the reader for reference as this section describes the SOLO model in more detail.

SOLO taxonomy is used to consider the responses that students provide to cues from educators. The model is understood in terms of student use of three types of component: irrelevant concepts, relevant concepts explicitly taught, and relevant concepts not explicitly taught. As demonstrated in Figure 1, as

**Figure 1: Diagram demonstrating the five levels of learning maturity as conceptualised in the SOLO taxonomy Framework with key. Developed from Biggs and Collins (1982).**



learning becomes more mature, learners are able to respond to teachers' cues with outcomes that include more relevant, and more numerous concepts. At the highest levels of the taxonomy students are also able to include information that is not only relevant but that has not been explicitly covered or linked to the topic by the educator. Another characteristic that discriminates mature learning is the learner's use of relating operations. At the higher levels of maturity of learning outcome students are able to link more concepts together in more diverse ways, whether this be by comparison, contrasting or another relating operation. Finally, students at the highest levels of learning maturity are able to demonstrate a tolerance of ambiguity in their work. Often less mature work demonstrates premature closure of arguments, for example providing only one explanation for a finding as opposed to considering multiple possibilities.

## Use of SOLO taxonomy for scaffolding

This section of this paper will explore four common dilemmas faced by university educators of psychology. For each dilemma the following format will be utilised: Description of example vignette, identification and justification of current level of SOLO taxonomy at which students are performing, identification of target SOLO taxonomy stage for learning outcomes, and an example scaffolding technique for supporting students to make this step. All scaffolding techniques discussed in this section are based on common classroom strategies used in secondary schools by teachers but adapted for the university lecture setting. It is hoped that these examples will bring SOLO taxonomy to life for the reader and may inspire further thinking regarding the practical strategies educators in university lecture hall settings can employ to scaffold learning for diverse pupil cohorts. It is worth noting that these examples have been simplified to suggest that cohorts of students will have a shared starting point on the SOLO taxonomy framework for ease of comprehension. However, as highlighted by the discussion of lecture hall inequality this is unlikely and it will be more often the case that students will vary in their stages of learning maturity and scaffolding techniques will be targeted as sub-groups of pupils.

### Dilemma 1: Problem solving

A lecturer is delivering a research skills module to a group of first year undergraduates in psychology. The lecture focuses on the concepts of demand characteristics and ecological validity. The lecturer wants to assess student's understanding of these concepts by examining their next laboratory reports. Upon examining these reports, the lecturer notices that most students have included a definition of demand characteristics and a definition of ecological validity, but they have failed to use these concepts to inform their experimental designs. The lecturer hopes to address this problem before students complete their next laboratory report.

#### *Identify current student level*

Students who are presenting only the definitions of demand characteristics and ecological validity but failing to use these to inform their experimental designs, are likely currently at the multi-structural level of understanding. They are able to respond to the assignment by providing several relevant pieces of information, the two definitions, but they do not make links between these concepts and the design aspects of their study.

#### *Identify target student level*

The lecturer's target level for these students is most likely the relational level of understanding. The lecturer wishes for students to respond to the given assignment with several relevant points of information, the definitions for demand characteristics and ecological validity, and wishes them to make links between these relevant elements and other aspects of the experiment such as the experimental design or methodology.

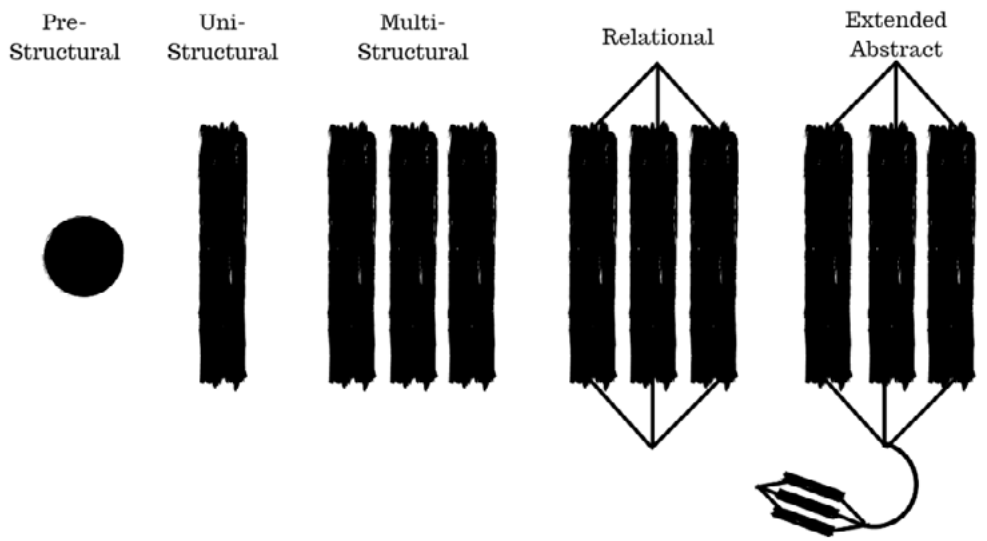
***Possible scaffolding strategy***

A possible scaffolding strategy for the lecturer to utilise is known as transparent marking. Students at any level of education can struggle to identify what examiners look for to identify high quality assignments. One strategy which can increase alignment between student and educator expectations is sharing the stages of the marking process and being explicit in the criteria fulfilled in assignments. A practical method for using this idea in a lecture hall setting is by utilisation of a virtual learning environment. A lecturer may share various fictional examples of student work with a student cohort and ask students to mark this work using a provided framework, for example a simplified version of SOLO taxonomy (see Figure 2). The lecturer will then share the grades they would give to each fictional example and justify these with reference to the marking criteria. Variations on such a strategy could involve the use of lecture-friendly voting software to allow students to share in real-time their gradings for each example and how these change over time during the lecturer's explanation. This would have the added benefit of allowing the lecturer to monitor development in student's understanding of the marking criteria over the course of the lecture. A further variation could be to complete the same activity with students in small groups or pairs to encourage collaboration and deeper discussions about the meaning of different aspects of the marking framework.

**Dilemma 2: Integrating new knowledge**

A lecturer is delivering a course to second year undergraduates in psychology which covers debates in the language acquisition of infants. The lecturer is confident that all students completing the course are able to describe the debate between nativist and social constructivist ideas of language acquisition in infants. The course is to be assessed on a critical essay concerning this language acquisition debate but the lecturer is concerned that students will only include studies explicitly covered in lectures and fail to make links to other studies beyond this small number.

**Figure 2:** Simplified diagram demonstrating levels of SOLO taxonomy in sharable format for students including key word descriptors or prompts.



***Identify current student level***

Students are likely currently at the relational level of understanding or at the transitional point between the relational and extended abstract levels of understanding. They are able to respond to an assignment cue with multiple relevant pieces of information, in this case research studies covered in lectures, and make links from these studies to the relevant debates around language acquisition. However, they are unable to integrate new pieces of relevant information from studies not explicitly covered in the lecture material. It could be argued that students are in the transitional point between these two levels as they are able to use multiple explanations to explain the presented studies, the two different theories of language acquisition.

***Identify target student level***

The target level for these students is the extended abstract level of understanding. The lecturer wishes for students to be able to make links between both explicitly presented and non-explicitly presented research studies and the language acquisition debate. It is also expected for students to make links or comparisons between study evidence and use more than one explanation in their critical essays, for example using both the nativism and social constructivist theory explanations of study findings.

***Possible scaffolding strategy***

A scaffolding strategy which may aid the lecturer from this vignette is the construction of a collaborative platform for students to practice and model for each other the integration of new information required for students to reach the extended abstract level of learning outcome. An online platform such as Padlet or a forum constructed in a university specific virtual learning environment could be used. For a small number of credits or as a homework between lectures students could be required to submit a small post about a paper that has not been explicitly covered in lectures but is related to the language acquisition debate. By providing a full reference for this paper and a one-sentence explanation of how this study links to the language acquisition debate students will be explicitly demonstrating and developing the skills required to improve the quality of their work, making links between new relevant information and the learning cue provided.

## Dilemma 3: Making value judgements

A lecturer is teaching a module to final year undergraduates in psychology which examines evidence regarding localisation of brain functioning. Students are expected to write a critical essay examining the strength of evidence supporting a localised model of brain functioning. Upon marking student's essays, the lecturer notices that many students are able to describe studies that evidence localisation of brain functioning. However, students do not appear to be making links to other modules where they have been learning about how to critically evaluate research evidence and, thus, they have not identified the strengths and weaknesses of the studies they have included.

***Identify current student level***

Students are likely currently at the multi-structural level of understanding. They demonstrate an ability to describe studies that are related the localised model of brain functioning but they do not make links between these studies and what they have learnt about the quality of the presented research evidence.

***Identify target student level***

The target level for these students is, at a minimum, the relational level of understanding, with possibly some students obtaining the extended abstract level. The lecturer wishes for students to make connections between pieces of evidence, for example making comparisons between the quality of different studies which relate to the localised model of brain functioning. It may also be that students will need to achieve the extended abstract level if they bring in relevant information from different university modules that have not been specifically alluded to by the lecturer.

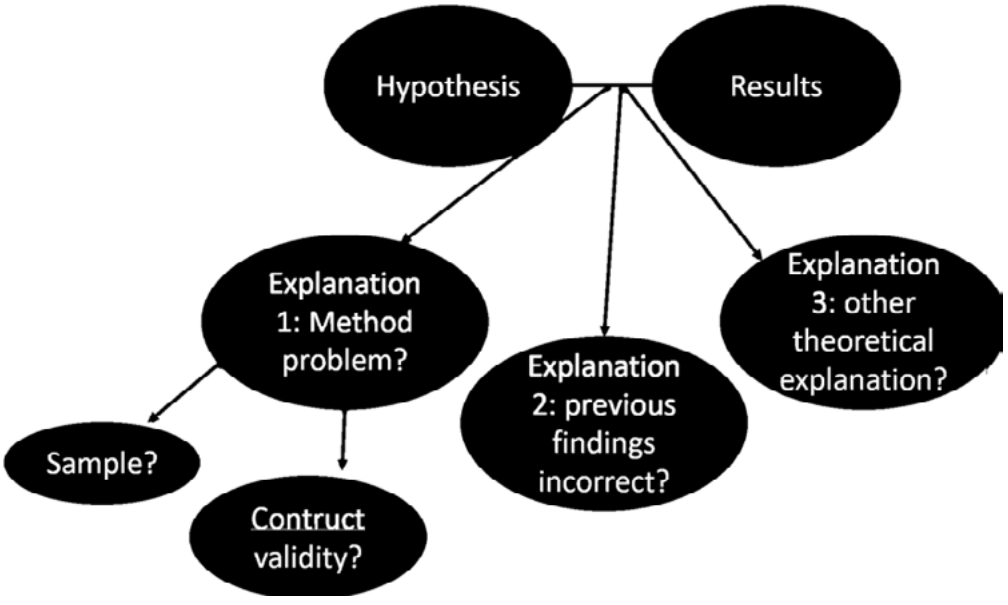
***Possible scaffolding strategy***

One strategy which could allow these students to reach these higher quality learning outcomes is known as constructing a shared toolkit. The lecturer could label several key readings from the module, for example, text A, text B and so forth. Using a online platform, such as Socrative or Mentimeter, students in the lecture hall can be invited to rank these texts in terms of the quality of evidence. From this exercise the lecturer could call on students, or make further use of online feedback platforms, to construct a criterion sheet, listing characteristics which students may look for in a high-quality research paper and in a low-quality research paper. This criterion sheet could then be shared with students and used as a tool to guide the evaluation of new papers, modelling and making explicit the process by which researchers examine new research work.

**Dilemma 4: Providing causal explanations**

A lecturer is running a research methods module for second year undergraduates in psychology. Students are to be assessed on this module with the use of a laboratory report in the style of a scientific paper about a computer-based experiment on decision making students conducted in small groups. Many of the groups have findings from their decision-making experiment that contradicts the hypotheses they stated while planning their study. In previous laboratory reports, it has been noted by markers that in previous laboratory report assignments where students' results have not supported their hypotheses that students simply state that this is due to having a 'small sample size' making their results invalid rather than consideration of any alternative explanations. The lecturer for this module wishes to ensure that students learn to be able to evaluate, compare and consider several alternate explanations of unexpected findings as this is a skill pertinent to careers in research work.

**Figure 3: Example partially constructed template for guiding students in writing discussion sections on the basis of hypotheses and results of their research studies.**



***Identify current student level***

Students in this vignette are likely currently in the relational level of understanding. They are able to make a connection between evidence which fails to support their proposed hypotheses and the small sample sizes of their experiments. However, they are unable to consider multiple explanations of the same finding – therefore showing premature closure of their arguments and a lack of ability to hold ambiguity.

***Identify target student level***

The target level for these students is the extended abstract level of understanding. At this level, students would be able to provide several possible explanations for their findings failing to support their hypotheses based on a range of factors, for example: methodological limitations and theoretical explanations.

***Possible scaffolding strategy***

A common characteristic of extended abstract work is the ability to hold several conflicting explanations without premature closure of one's argument. Therefore, this skill could be modelled by the lecturer using a guided example strategy. The lecturer could develop a template for the discussion section of an example laboratory report. This could be in the form of a flow chart and link different areas of discussion to key terms covered in lectures as shown in Figure 3. To engage students more deeply in this exercise the lecturer could leave the template partially constructed and ask students to work in small groups to add to and develop this, making links to their own laboratory reports.

## Limitations and notes regarding use of SOLO taxonomy

It is worthwhile highlighting, at this point, several areas which educators may wish to consider in when applying SOLO taxonomy to their practice. Firstly, while SOLO taxonomy allows consistent understanding of maturity of learning from an educator's perspective it is advantageous to share a version of SOLO taxonomy, perhaps in the form shown in Figure 2, with students to allow them to self-monitor and understand educator expectations. Secondly, not all tasks set for students will be of a form that allows the demonstration of the higher levels of SOLO taxonomy. For example, it is not possible to demonstrate advanced abstract levels of learning on multiple choice quizzes. It is, therefore, important to consider carefully the wording and format of assignments which educators plan to assess using this framework. Finally, while SOLO taxonomy can be hugely beneficial in planning scaffolding strategies which can address instances of inequality in the lecture hall, this is not the only factor which determines student's learning outcomes. Educators ought still to consider the role of time allocated for tasks, emotional investment of students, motivational factors and other situational influences on student work.

## Conclusions

In conclusion, it is apparent that as higher educational settings open their doors to increasingly diverse groups of students that the inequalities that have always been present in lecture halls are growing. This increases the pressure on university lecturers to explicitly consider how to differentiate for students at different stages in their learning journeys to allow all students to reach their full potential. In this way, university educators may benefit from the scaffolding techniques which are commonplace in the secondary school classroom. SOLO taxonomy provides a useful framework for considering the level of student learning outcomes and for planning scaffolding strategies. Four scaffolding techniques that may be applied from the lecture hall if modified from their original classroom setting form are: transparent marking, shared toolkits, collaborative platforms and guided examples. University educators ought to be encouraged and supported to cater for the wide range of students in their lecture halls and the use of consistent framework such as SOLO taxonomy can aid in the development of innovative and targeted scaffolding strategies.

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