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Scaffolding to Improve Learners' Understanding

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Abstract

The current practice of pedagogy and assessment, particularly in the blended learning mode, necessitates learners to be highly motivated and independent in order to be able to take full autonomy of their learning. By using scaffolding techniques, an instructor can identify learning difficulties at different stages of the learning process and take corrective measures to achieve optimal results. This paper discusses the use of scaffolding techniques in a mathematics classroom and investigates students' responsiveness towards this technique by analyzing the students' performance in the final examination. Suggestions are given on how the instructions can be modified to have a better scaffolding in future.

Keywords: *Hypothesis Test, Blended Learning, Independent Learning, Scaffolding*

Introduction

According to Wilson and Devereux (2014), the concept of scaffolding originates from Vygotsky's (1978) theories of social learning. On the other hand, Bakker, Smit and Wegerif (2015) argued that the '*complicated*' history of scaffolding dates back to Ausubel's (1963) work on Piagetian constructivism as opposed to the Vygotskian constructivism. However, the authors agree that Wood, Bruner and Ross (1976) were the first known to extensively discuss the metaphor of scaffolding by defining it as ''*the process that enables a child or novice to solve a problem, carry out a task, or achieve a goal which would be beyond his unassisted efforts*'' (p. 1047).

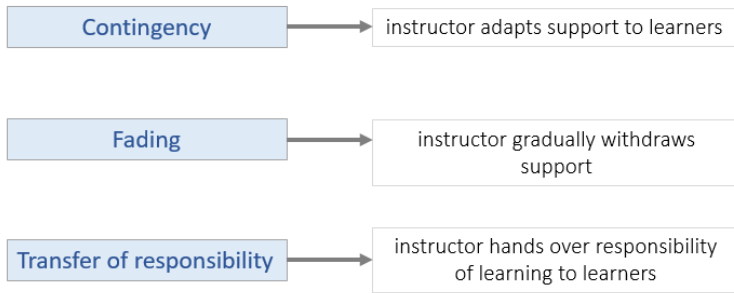

Figure 1: Central characteristics of scaffolding

Over time, the definitions of scaffolding have included for example, help that enables learners to reach competence (Maybin, Mercer & Stierer, 1992) and temporary support that moves learners towards new levels of understanding (Gibbons, 2002). Of the more recent definitions, Van de Pol, Volman and Beishuizen (2010) defined scaffolding by considering three central characteristics shown in Figure 1. On the other hand, diagnosis, responsiveness and handover to independence are the defining characteristics of scaffolding stated by Smit, van Eerde and Bakker (2013), particularly in the context of whole-class scaffolding.

Scaffolding in Education

In the educational contexts, scaffolding refers to a variety of instructional strategies used to move learners progressively towards deeper levels of understanding and greater independence in the learning process whereby the instructor's role is to provide support and assistance at successive levels. The instructor encourages, motivates and guides the learners to reach higher levels of comprehension and skills acquisition. In that sense, we would agree that all teaching involves some form of instructional scaffolding. A simple example of this is where the instructor demonstrates solutions to routine problems and after that get the learners to work on more difficult problems.

A review of literature on scaffolding in mathematics education by Bakker, Smit and Wegerif (2015) found that there are studies focusing on social scaffolding (e.g., Makar, Bakker & Ben-Zvi, 2015), there are studies concerning learners' dispositions and mathematical problem solving skills (e.g., Toh et al., 2014), and studies concerning the teachers who are involved in scaffolding (e.g., Visnovska & Cobb, 2015). An important conclusion made by Bakker, Smit and Wegerif (2015) from their review is that diagnosis of the learning process, especially of the disadvantaged learners, is needed and should be an ongoing process.

Kazak, Wegerif and Fujita (2015) explored the use of scaffolding to develop learners' conceptual understanding of probability and found that combining content scaffolding and dialogue scaffolding is an effective strategy to promote learners' conceptual development. Several other studies have recorded positive results in using scaffolding to promote students' learning of mathematics (e.g., Abdu, Schwarz & Mavrikis, 2015; Amiripour, Amir-Mofidi & Shahvarani, 2012; Chase & Abrahamson, 2015).

This paper discusses an example of scaffolding approach used to teach the topic hypothesis test to a group of undergraduate engineering students.

An Exemplar

Figure 2 shows the scaffolding activities used to teach hypothesis test to a group of undergraduate engineering students at a higher education institution. The lesson was conducted in a blended learning mode using the flipped classroom approach. First, the students were assigned a reading assignment on the online mode. The reading assignment is an independent learning activity whereby students were asked to go through two sets or power point slides containing explanations about hypothesis test and the hypothesis testing procedure (see, Krishnan, 2018).

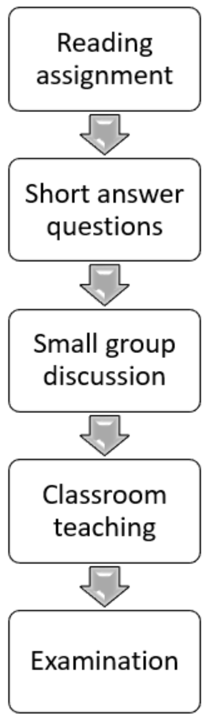

Figure 2: Scaffolding activities

The reading assignment is followed by students having to complete one of three sets of short answer questions that must be done before the face-to-face mode in a usual classroom setting. The face-to-face learning took place over two lessons. In the first lesson, collaborative learning in the form of small group discussion was conducted whereby each group of four students were given two hypothesis test problem situations to solve. An example of the problem can be found in Krishnan (2018). As with Krishnan (2018), it was observed that students were actively engaged in the learning process and most of them succeeded in solving the problems. In fact, active discussions between different groups were observed and a lot of interactions and knowledge sharing took place during these discussions.

In the second lesson, the instructor worked out the solutions, on the whiteboard, for some of the problems solved during the collaborative learning. The objective of this activity is to ensure that all students, especially the ones needing more support, have also understood the hypothesis testing procedure. The students were finally assessed on their learning of hypothesis test through a final examination question. It was an optional question, one out of five questions.

It was found that forty-five out of forty-nine engineering students (91.84%) chose this question in the final examination. Further, 51.11% of those students who attempted the hypothesis question obtained at least half of the full marks for this question while 20% of them succeeded in obtaining full marks. Firstly, this shows that students were confident of their independent learning to want to attempt the hypothesis test question in their final examination. Secondly, one fifth of these students succeeded in getting full marks showing that they have the procedural knowledge in terms of the steps in conducting a hypothesis test.

More importantly, it indicates that students have attained the conceptual knowledge since they are able to identify and differentiate between sample and population, decipher the information given in the problem situation, and interpret and communicate the results of the hypothesis testing procedure.

Discussion and Conclusion

As pointed out by Wilson and Devereux (2014), the metaphor of scaffolding induced different interpretations and while support is essential in a scaffolding activity, the nature of the support is more crucial. The scaffolding approach described in this paper was found to be quite successful possibly because a combination of instructional strategies was used in the blended learning mode.

In addition, the success rate of any instructional strategies and pedagogical approaches depends on a number of factors such as learning preferences and group dynamics as mentioned in Krishnan (2015). In view of the blended mode in which learning took place in this exemplar, an important factor is learners' threshold of independence. The independent learning prior to the classroom activity is crucial and thus if learners are not independent enough to carry out the former productively, the latter will be jeopardized.

Limitations of this study are the small sample size and that it only concerns one batch of students. Future work with regards to this paper will be to extend the study to include more students from different cohorts. Another possibility is to switch the order of the instructional strategies or to change the type of instructional strategies and to analyze learners' performance with respect to different combinations and sequences of the instructional strategies used in the scaffolding.

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