



Abstract. *This research reports the development of an online three-tier diagnostic instrument for pre-university students related to cellular respiration. To date, only few studies have been conducted to identify students' alternative conception in the topic of cellular respiration. One of the contributing factors is due to lack of instrument developed to measure these alternative conceptions. Three-tier tests are used as assessment tools for lecturers to determine students' alternative conceptions related to cellular respiration and their knowledge and understanding about the concepts. The research incorporates both qualitative and quantitative methods. The instrument was developed in five phases: (1) construction of items, (2) pilot study, (3) validation of instrument, (4) transforming the instrument into an online assessment tool, and (5) the administration of the Online Diagnostic Tool (ODiT). The Cellular Respiration ODiT consists of three tiers: answer and reasoning tiers to measure "content knowledge" and "explanatory knowledge" respectively, and a third tier that measures the level of confidence of pre-university students. Analysis of the students' responses demonstrated acceptable reliability and validity of the instrument. The research also shows that both students and lecturers benefit when online diagnostic tests are implemented appropriately.*

Key words: *biology alternative conception, online diagnostic tool, three-tier diagnostic test.*

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DEVELOPMENT OF AN ONLINE THREE-TIER DIAGNOSTIC TEST TO ASSESS PRE-UNIVERSITY STUDENTS' UNDERSTANDING OF CELLULAR RESPIRATION

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Introduction

Students come to biology class with prior knowledge and this knowledge affects the way learners perceive new scientific information. Some part of this knowledge can be different or in conflict with the information that is generally accepted by scientists (Mutlu & Sesen, 2016; Taslidere, 2016). The alternative information may stand in the way of learning biological concepts in a meaningful way and could possibly obstruct the acquisition of new knowledge (Lazarowitz & Lieb, 2006). It is now widely acknowledged that students' alternative conceptions in biology can impede their learning and meaningful understanding of the subject (Anderson, 1986; Palmer, 2001; Taslidere, 2016). In this research, alternative conception refers to students' conceptions that conflict with scientific information. Biology misconceptions have been recognized as a major factor affecting students' understanding of science at the secondary school level with many of these misconceptions being carried onwards to the university level (Coll & Treagust, 2003). Research on students' understanding of cellular respiration revealed an array of misconceptions and inaccurate conceptualizations among secondary school students (Lazarowitz & Lieb, 2006; Halimin & Shamsudin, 2016), as well as pre-service science teachers (Yakistan, 2016; Galvin, Simmie, & O'Grady, 2015). For instance, a study conducted by Yusof, Halimin, and Shamsudin (2016) investigated the understanding of diffusion, osmosis, and the particulate theory of matter and found that university students' understanding of the particulate theory of matter was unsatisfactory. Similarly, Galvin, Simmie, and O'Grady (2015) investigated misconceptions about respiration and photosynthesis and found an unacceptably high level of misconceptions among all pre-service teachers and suggested that diagnostic tests can be a useful entry point to a pedagogical cycle for the recognition, reduction, and removal of misconceptions.

