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Development of an instructional model for higher order thinking in science among secondary school students: a fuzzy Delphi approach

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ABSTRACT

It is important for science students to develop higher order thinking (HOT) so that they can reason like scientists in the field. In this study, a HOT instructional model for secondary school science was developed with experts. The model would focus on reflective thinking (RT) and science process skills (SPS) among Grade 7 students. The Fuzzy Delphi Method (FDM) was employed to determine consensus among a panel of 20 experts. First, semi-structured interviews were conducted among the experts to generate the elements required for the model. Then, a questionnaire was developed using a seven-point linguistic scale based on these elements. The defuzzification value was calculated for each item, and a threshold value ($d$) of 0.75 was used to determine consensus for the items in the questionnaire. The alpha-cut value of $>0.5$ was used to select the phases and sub-phases in the model. The elements in the model were ranked to identify the sub-phases which had to be emphasised for implementation in instruction. Consensus was achieved on the phases of the HOT instructional model: engagement, investigation, explanation, conclusion and reflection. An additional 24 learning activities to encourage RT skills and SPS among students were also identified to develop HOT skills in science.

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KEYWORDS

Higher order thinking; Fuzzy Delphi Method; reflective thinking; science process skills; instructional model

INTRODUCTION

Science as an inquiry involves reflection on one’s experiences when reasoning about a phenomenon. The process of scientific inquiry and reasoning produces new scientific knowledge (Gyllenpalm, Wickman, & Holmgren, 2010). Scientific inquiry has been defined as a systematic approach used by scientists in finding the answers to questions about a certain phenomenon (Lederman, 2004). It involves the use of the science process skills (SPS) for observation, measurement, experimentation, and reasoning. However, scientific inquiry has often been referred to a set of skills to be learned through experimental research, using the manipulation of variables to determine causal relationships (Gyllenpalm et al., 2010). This view of scientific inquiry neglects the...