TEACHING STRATEGIES SCALE FOR PROMOTING HIGHER ORDER THINKING SKILLS AMONG STUDENTS IN SCIENCE

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Abstract: It has been well verified that higher order thinking skills (HOTS) are essential for effective learning and form the central goal of science education. Based on the recent literature, teaching methods play a vital role in enhancing students’ acquisition of HOT. This study aimed to develop a strategies use survey questionnaire that aim to investigate the strategies use by science teachers in to teach their students’ HOT in science. The questionnaire was developed based on the construct of higher order thinking and consisted of 34 items in the form of 5 point Likert scale. The questionnaire was distributed among 88 7th grade science teachers in the Iraqi-Kurdistan region. After identifying the validity and reliability of the questionnaire, three items were dropped and the final version of the strategies use survey questionnaire consisted of the 31 items with alpha Cronbach 0.899. Which implies that the scale can be used as a reliable source to assess the strategies use by science teacher to teach their students higher order thinking skills in science.

Keywords: Teaching Strategies questionnaire, Higher Order Thinking Skills, Teaching Science.

I. INTRODUCTION

Fostering HOT among students of all ages is considered as an important educational goal and form a central goal for science education, in order to enable them to face the challenges of daily life by enhancing students’ higher cognitive skills such as critical, reasoning, reflective and science process skills (Davidson & Worsham, 1992; Zachariades, Christou, & Pitta-Pantazi, 2013). However teachers often believe that this important goal is not intended for all students (Zohar, Degani, & Vaaknin, 2001). The common belief among teachers is that, tasks requiring HOT are appropriate only for high achieving students, whereas low achieving students, who can barely master the basic facts, are unable to deal with such tasks (Zohar, 1999). Yao (2012) emphasized that one of the recommendations of the National Research Council’s study (NRCS) on facilitating HOT among students is that teachers must create an environment in which students feel comfortable sharing their ideas, invention and personal meaning. Moreover, according to Miri, David, and Marshall and Horton (2011) there are two main steps for improving HOTS among students. First, is to create an environment for students to explore more about the complex problems by asking open-ended questions. Second, is giving opportunities for all students to think about their own thinking through group activities. More specifically, the teacher should use the teaching methods that requires active participation of students, by engaging them in generating questions, representing their understanding, solving complex problems and reconstructing their own thinking (Albaaly 2012; Panasan & Nuangchalem, 2010; Şimşek & Kabapınar, 2010), so as to improve their higher cognitive skills which would further help them to become a decision maker and solve their problem in daily life situations. In addition, an increasing body of research has focused on the relationship between the use of effective teaching methods and students’ cognitive skills (Constantinou & Kuys, 2013; Karami, Pakmehr, & Aghili, 2012; Rotgans & Schmidt, 2011; Thitima & Sumalee, 2012; Williams, 2000). Moreover, based on the researcher’s best knowledge there is no questionnaire to investigate the teacher strategy use for enhancing higher order thinking among students in science. Therefore, this study aimed to develop a strategy use survey questionnaire (SUSQ) to investigate the strategies use by science teacher to teach their students higher order thinking skills in science.

II. LITERATURE REVIEW

HOT can be conceptualized as a non- algorithmic, complex mode of thinking that often generates multiple solutions to the proposed problem (Newmann, 1990). Moreover, based on the theories of cognitive development and Bloom taxonomy, research identified three main constructs of HOT as follows:

1- Acquiring knowledge: by activating students’ prior knowledge or retrieving relevant knowledge from long term memory, students can gather the information in order to understand the phenomena, by using basic thinking skills such as defining terminology, classifying and comparing (Aktamis & Yenice, 2010; Jong et al., 1998) which is LOTS, these basic skills play a critical role in supporting the development of higher thinking skills (Zohar & Dori, 2003).

2- Applying knowledge. Students must be encouraged to work with data or material using different thinking skills to move to deep understanding of the usefulness and applicability of this material to everyday life, by using
integrated science process skills ISPS (Lati, Supasorn, & Promarak, 2012; Qin, 2011).

3- Reflection on knowledge. This dimension requires students to use higher level of thinking skills in order to analyze and make judgment about what has happened, which will increase students’ reflective thinking (Phan, 2009; Zachariades et al., 2013).

However, past studies advocated that effective strategies for developing students’ HOT should have four important characteristics. First; activating the student’s prior knowledge; that would assist them to make connections between the pervious knowledge and the new information they will be learning. By tapping into what students already know, teachers can support students with the learning process. Second; using classroom activities; these will provide students with background science information, straightforward steps, and gives them the opportunity for hands-on inquiry for seeking science inspiration. Many of these activities can be prepared and completed in a short time, making them easy to integrate into a classroom setting. Third; grouping approach, sharing experiences in small group activities will improve students’ knowledge and help them to apply the acquired knowledge into real life situations. Fourth; assessment forms; science teachers should use different form of assessment such as alternative assessment and evaluation approaches. Therefore, SUSQ has been developed based on the three constructs of higher order thinking and the above characteristics of the teaching strategies for promoting higher order thinking skills among students.

III. METHOD

In order to identify the strategies uses by 7th grade science teachers to teach their students HOT, the researcher developed a strategy use survey questionnaire (SUSQ) which is consisted of (34) questions in the form of 5-piont liker scale (1= always to 5= never) based on the three constructs of cognitive development. As, questions (1-15) measures the strategy used for acquiring the knowledge that aims to improve students’ basic thinking skills. Items (16-23) seeks out to measures the strategies used by science teacher for applying knowledge and reflection on knowledge as in items (24-34), in which these strategies aid students’ to improve their higher cognitive skills in science learning.

3.1 Data Collection and analysis

The data collection is done by self-administration the final version of the SUSQ after getting ethical approval from the Ministry of Education in Duhok city in order to conduct a study. The questionnaire is distributed among 88 7th grade science teacher. The participants are asked for their willingness to participant in the study, once the verbal consent is obtained, the essential instructions and information about how to fill-up the questionnaire was explained for them. The participants have given enough time to answer all questions as the questionnaires were collected after one week of the administered date. The study data were analyzed using descriptive statistics via Statistical Package for the Social Sciences (SPSS) Version 21.

IV. RESULTS AND DISCUSSION

The questionnaire was conducted with 88 7th grade science teachers in Duhok city in the Iraqi Kurdistan region, the survey received a high response rate of 81.1%. The validity of the SUS is verified by identifying the Content validity ratio CVR. The content validity ratio's formula (CVR) was developed by Lawshe in 1975: \[ CVR = \frac{n-N/2}{N/2} \] where \( n \) is number of arbitrators indicating essential, and \( N \) is the total number of arbitrators(Lawshe, 1975). In addition, Lawshe provided a table of critical values for the content validity ratio. The researcher offered the SUS to a group of 11 experts in science teaching method, measurement and evaluation and educational psychology. According to Lawshe’s table, the critical value in case of 11 arbitrators starts from .59. As a result items 12, 16, 17, and 21 have been modified based on experts’ feedback.

Table 1: Validity of the Strategies Use Survey Questionnaire.

<table>
<thead>
<tr>
<th>Questionnaire constructs</th>
<th>Items</th>
<th>CVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquiring Knowledge</td>
<td>I organize students to observe scientific phenomena.</td>
<td>.62</td>
</tr>
<tr>
<td></td>
<td>I try to increase students’ interest toward scientific problems.</td>
<td>.79</td>
</tr>
<tr>
<td></td>
<td>I focus on learning students basic concepts.</td>
<td>.77</td>
</tr>
<tr>
<td></td>
<td>I organize students in which students compare objects using standardized units of measure.</td>
<td>.80</td>
</tr>
<tr>
<td></td>
<td>I ask students to explain concepts to one another.</td>
<td>.66</td>
</tr>
<tr>
<td></td>
<td>I devise exercise in which students have to conduct investigation.</td>
<td>.66</td>
</tr>
<tr>
<td></td>
<td>I encourage students to generate their own questions.</td>
<td>.72</td>
</tr>
<tr>
<td></td>
<td>I give students scientific problems in which they are encouraged to construct hypothesis.</td>
<td>.78</td>
</tr>
</tbody>
</table>

The reliability of the questionnaire was identified by internal consistency coefficient "Cronbach’s alpha" methods (Christmann & Van Aelst, 2006). Furthermore, after the process of applying the questionnaire to the exploratory sample, the researcher used SPSS software to estimate the questionnaires’ reliability by and internal consistency coefficient "Cronbach’s alpha" methods. This method is based on calculation of the correlation coefficient between the different items on the same questionnaire. 88 usable questionnaires were used to calculate the Coefficient alpha for the proposed constructs of SUS. Table 2 shows Cronbach’s alpha results for three proposed constructs. As shown in the table, the initial Cronbach’s alpha coefficients of acquiring knowledge construct (.782), and reflection of knowledge (.715), while applying knowledge construct (.679) is below the .70 threshold recommended value (Hair & Black, 2010). In order to gain the highest possible reliability coefficient, the components were purified by dropping items with the lowest item-to-total correlation. For acquiring knowledge construct item (ACQ15) is deleted due to a low item-total correlation. Two items, one item from applying knowledge construct and one from reflection of knowledge were dropped due to the coefficient alpha values. After excluding unreliable items. The revised items demonstrated coefficient alpha values of each construct and for overall Questionnaire are within the acceptable range as in table 2. Thus the final SUS consist of 31 items.

Table 1: Reliability Analysis (Cronbach’s Alpha Coefficient) For Proposed Dimensions

<table>
<thead>
<tr>
<th>Construct</th>
<th>NO. of Items</th>
<th>Cronbach’s Alpha</th>
<th>NO. of Items</th>
<th>Revised reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquiring Knowledge</td>
<td>15</td>
<td>.782</td>
<td>14</td>
<td>.794</td>
</tr>
<tr>
<td>Applying Knowledge</td>
<td>9</td>
<td>.679</td>
<td>8</td>
<td>.708</td>
</tr>
<tr>
<td>Reflection on Knowledge</td>
<td>10</td>
<td>.715</td>
<td>9</td>
<td>.739</td>
</tr>
<tr>
<td>Whole SUS</td>
<td>34</td>
<td>.899</td>
<td>31</td>
<td>.899</td>
</tr>
</tbody>
</table>

CONCLUSION AND IMPLICATION

Based on the recent literature, teaching strategy play a vital role in enhancing students’ acquisition of HOTS. However, after searching the literature the results shows that there is a lack of literature that seeks to develop a stander questionnaire to investigate the strategy use by science teachers to teach their students higher order thinking skills in science. After identifying the validity and reliability of the strategies survey questionnaire based on the experts and science teachers’ feedback, the final version of the questionnaire consisted of 31 items distributed into three main constructs; acquiring knowledge, applying knowledge and reflection on knowledge. The items under each construct seeks to measure the strategies use for activating students’ prior knowledge, activities.
use and forms of assessment use. In which these strategies aims to improve students’ higher order thinking skills in science.

However, the findings of the study have important implication for teachers and curriculum designer in science education. First, the science teacher could get the benefit from the findings of the study in acquainted the weakness of their teaching methods so as to make effort to improved it. Second, instructional designer could use the findings of this study to distinguish to what extent the science teachers using the activities that encourage students to use their higher cognitive skills so as to think on a serious solution such as holding specialized courses for science teachers and encourage them to use the different teaching strategies, especially the cognitive strategies.

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