Assessing Learning, Teaching and Thinking Levels in Y7-13 in Science, Biology and Chemistry at Tarawera High School, New Zealand

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Abstract: Science, Biology and Chemistry at one New Zealand high school are taught using several approaches. This paper uses a pre-defined combination of Bigg’s model of constructive alignment, Bloom’s taxonomy and Biggs and Collis’ SOLO taxonomy to identify the occurrence of the multi structural thinking level in current assessments and teaching/learning strategies of science, chemistry and biology for Y7-13. This is an attempt to identify opportunities for students to develop their thinking levels. Focus group interviews, teacher and student-directed structured questionnaires and structured analyses of current assessments target the multi-structural thinking level. Preliminary data shows a 10% frequency of this level at Y7-9, 36% at Y10-11 and 30% at Y12-13. The research work refers to other thinking levels for evaluation purposes. The researchers suggest that a well-structured blend of informed teachers, students, and curricula, teaching methods and assessment design and procedures is essential to raise the current thinking, learning and teaching level in the emphasized learning areas. The paper also acknowledges the importance of the psychological and social climate of both classroom and institution for fostering the development of thinking levels.

Keywords: Biggs & Collis SOLO Taxonomy, Thinking/learning/teaching levels, teaching strategies, learning assessments.

1. Introduction

Thinking is identified as a key competency within Curriculum Marautanga Project. It is a skill that allows for lifelong creativity and productivity (Rutherford, 2005; Rychen, 200; Hook, 2012). With the completion of Term 1 at Tarawera High School, the Science department recognises a need to evaluate the thinking/teaching/learning levels of its learning community (teachers and students). This allows students to know themselves better as learners, enhance their self-regulation and improve their thinking levels. The current thinking levels of Y7-13 science, biology and chemistry students are evaluated using pre-defined combination of Bloom’s taxonomy and Biggs and Collis’ SOLO taxonomy.

SOLO (Structure of Observed Learning Outcomes) taxonomy provides the learning community with an understanding of thinking. Teachers find it helpful when preparing lesson plans, defining learning objectives and delivering lessons. It creates effective partnerships among teachers, students and parents, when implemented systematically and uniformly. It also creates a comfortable environment that engages the students in the learning process. The clear and distinct terminology of SOLO taxonomy can easily make the interpretation of an assessment a simple task that allows teachers and students feedback and feed forward on the learning outcome. Biggs and Collis define five SOLO taxonomy thinking levels: pre-structural, uni-structural, multi-structural, relational and extended abstract.

1) SOLO Pre-Structural Thinking Level
The learning outcomes at the pre-structural thinking level show unconnected information and no organization. This level is a starting point for teachers and students. The teacher can help the student breakdown the knowledge constituents and use them as an expansion point (Hook, 2012; Marfleet, 2012). Within the science, biology and chemistry curricula, teachers use audiovisual aids to solidify the understanding and allow the students another chance to test themselves (Hattie et al, 2004). This level does not exist in Bloom’s taxonomy (as revised by Anderson et al 2001) and is evaluated as fail by Bigg’s proposed levels of attainment.

2) **SOLO Uni-Structural Thinking Level**

This level is a surface level of understanding and reflects mastery of the basic concepts but an inability to manipulate the concept or present it within a different perspective. Students are able to make simple connection but cannot note any significance. The student is at “Just a Pass” level as classified by Bigg’s proposed level of attainment and is at the knowledge level in Bloom’s taxonomy. At this level, teachers should concentrate on building the knowledge store and encourage the students to do more with their knowledge base (Hattie & Brown, 2004; Hook, 2012).

3) **SOLO-Multi structural Thinking Level**

At this surface level of understanding, the students are able to make the connection between the concepts. They can identify, classify, combine information and give a descriptive overview. It is identified by Biggs as quite satisfactory and as the comprehension level by Bloom’s taxonomy. Students at this level need to work on integrating what is known into a coherent system within parts that are interrelated (Hattie & Brown 2004).

4) **SOLO-Relational Thinking Level**

This is the first deep understanding level. Students show full connections and synthesis of parts of the overall significance. Bloom’s taxonomy classifies this level as application and analysis and it is considered as highly satisfactory by Biggs’ levels of attainment. Student at this level can explain causes, analyze part and whole relationships, relate, compare and contrast. Venn diagrams, graphic organizers and concept maps are successful tools of this strategy (Marzano, R.J., 2001). Students at this level need to work hard to master abstract concepts and relationships. This allows them to derive more generalized principles and transfer understanding to new tasks and situations (Hattie & Brown, 2004; Hook, 2012; Marzano R.J., 2001).

5) **SOLO-Extended Abstract Thinking level**

The students at this level go beyond subject, link other concepts and generalize. They are capable of evaluating, predicting, theorizing, creating and reflecting. This level is described by Bloom’s taxonomy as synthesis, creation and evaluation level. Biggs’ proposed levels of attainments place this level as the very best...
understanding. While these levels are clearly distinguished, they require careful planning and follow up by teachers. The collaborative work of teachers in all disciplines can ensure its success. The ultimate goal of applying SOLO taxonomy is to have the students reach a stage to evaluate their own learning outcomes and ask: “what should I do next”. The next part of the paper discusses the importance of assessments in raising thinking levels.

2. Assessments for learning

SOLO taxonomy provides a roadmap for the learning community. Using simple terminology and careful design of formative, on-going and summative assessments, both students and teachers can evaluate the learning outcome. Assessments are an integral part of the learning\teaching\thinking levels and processes. An effective assessment should not only take into account the learning styles, needs and strengths of the students, but also help both teachers and students achieve the targeted learning outcome. Assessments are a learning tool that empowers students for life-long learning skills. According to Goode et al, an effective assessment should allow students to play an active role in their learning. It should have defined criteria and standards, and is collaborative including the teacher, self and peers feedback (Goode et al, 2010).

Integrating terminology of Biggs and Collis SOLO taxonomy in assessments upon discussing it with students is a powerful tool that involves students in the learning process and promotes higher thinking levels. It is essential that teachers present formative and on-going assessments as a learning tool that allows feedback. Tina Blythe and associates have identified several criteria to help refine on-going assessments. Criteria include clarity and relatedness to understanding goals, frequent opportunities for feedback, opportunities for multiple perspectives and providing formal and informal feedback (Blythe 1998; William 2006).

Peer and self-assessments are considered effective means by which students can enhance their thinking levels. If the teacher is the only one giving feedback, the balance is wrong and the students have no stake in learning. Peer and self-assessment have been found most efficient when the students are made aware of the learning objectives or success criteria. Given the criteria and good models of excellence, students can make their own improvements, assess their thinking levels and self-regulate themselves (Innovative Teacher Networks 2012); William 2006). The teachers should train students to work effectively in group discussions and model how to give constructive and formative feedback (Innovative Teacher Networks (2012). The ESRC Learning How to Learn Project stresses the importance of teaching students skills of collaboration and evaluative language for peer and self-assessment. Black et al suggest that students start with oral evaluation followed by the written evaluation and start at peer assessment followed by self-assessment (Black et al 2001, Innovative Teacher Networks, 2012, William 2006). The integration
of SOLO taxonomy concepts and terminology play a crucial role in designing assessments, setting success criteria, conducting assessment and providing feedback by teacher, student or peer. Students that can peer or self-assess will certainly gain the roadmap and motivation to move to a higher thinking level. Many researchers found that that students learn better by receiving comment-only feedback rather than grade only or grade and comment feedback (Black et al. 2001, William 2006).

3. SOLO Taxonomy Based Teaching Strategies

Teachers and teaching strategies represent the backbone of successful learning outcomes. Education systems around the world acknowledge the need for providing opportunities for students to develop their personal capabilities and effective thinking skills as a part of a well-rounded education. An effective means by which a teacher can help raise the thinking level within the classroom and foster critical thinking skills is to facilitate an active, inquiry based and participatory classroom. The teacher’s role in an active learning classroom ensures an effective shift towards: (i) learner centred classroom, (ii) process-centred learning, (iii) being an organizer of knowledge and an enabler, facilitating students’ in their learning and (iv) promoting a holistic learning approach. The students in an active classroom environment are participatory learners, asking questions, reflecting and collaborating learners (active learning and teaching methods for key stages, 2007).

Cooperative learning is another strategy that teachers should foster within an active and inquiry based participatory classroom environment to ensure higher levels of thinking. Teachers should carefully structure cooperative learning to ensure that a small team work together to maximize their learning accomplishing a common goal under conditions of positive interdependence, face-to-face, promotive interaction, individual accountability/personal responsibility, teamwork skills & group processing. Critical thinking is improved by a combination of student participation, teacher encouragement, and positive student-student interaction (Froyd, 2004, Smith 200a, Smith 200b, Smith 1996).

To help guide students to higher thinking levels, it is essential to solidify the interconnection between the professional goals of the teachers, the wants and needs of the students, the curriculum, the teaching strategies, the assessments methods and the way results are reported. This is all possible under proper psychological and social climate of the classroom and teaching institution (Biggs 2003). Figure 1- learning objectives.
4. Science at Tarawera High School

The science department has conducted several formative and summative assessments to provide feedback for improvement and decision making processes. The following Table 1 summarizes all conducted summative assessments during term 1.

*Table 1, shows all conducted summative assessments during term 1.*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Standard Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>2.1 (AS 91161)</td>
<td>Carry out quantitative analysis</td>
</tr>
<tr>
<td>Chemistry</td>
<td>3.1 (AS 91387)</td>
<td>Carry out an investigation in Chemistry involving quantitative analysis</td>
</tr>
<tr>
<td>Chemistry</td>
<td>3.7 (AS 91393)</td>
<td>Demonstrate understanding of oxidation-reduction process</td>
</tr>
<tr>
<td>Biology</td>
<td>2.1 (AS 91153)</td>
<td>Carry out a practical investigation in a biology context, with supervision</td>
</tr>
<tr>
<td>Biology</td>
<td>2.8 (AS 91160)</td>
<td>Investigate biological material at the microscopic level</td>
</tr>
<tr>
<td>Biology</td>
<td>3.1 (AS91601)</td>
<td>Carry out a practical investigation in a biological context, with guidance</td>
</tr>
<tr>
<td>Biology</td>
<td>3.7 (AS91607)</td>
<td>Demonstrate understanding of human manipulations of genetic transfer and its biological implications</td>
</tr>
<tr>
<td>Science</td>
<td>1.1 (AS90930)</td>
<td>Carry out a practical chemistry investigation, with direction</td>
</tr>
</tbody>
</table>

Scientific investigations and inquiry based research dominated the teaching\/learning approaches of Term 1 at the science department. Every achievement standard is started by a three to four weeks of theoretical background layout. Science, Biology
and Chemistry practical investigations apply a deductive approach. Students are asked to formulate a prediction, test it, and compose a conclusion and a discussion. Students are also encouraged to identify trends, incongruent results and inconsistencies, explain them and defend them whenever appropriate.

In 3.7 Level 3 Biology, the students are given a scientific background in genetic manipulation techniques and then allowed resources to formulate their own conclusions. Teachers identify and discuss clear learning objectives with their students. With the learning objective in focus, teachers guide and coach the students to help them develop their learning ownership. The term 1 practical investigations in Chemistry and Biology level 2 are initiated by a clear road map for a similar investigation that is closely monitored by the teacher. This allows the students to develop self-confidence and coaches them in their actual investigation. Students are strongly encouraged to link the outcomes of both investigations for comparisons and writing a more comprehensive discussion. Formative assessments are conducted in tandem with teaching and are currently marked by teachers.

5. Design and Methods

The current thinking/teaching levels of Y7-13 students and the teachers’ readiness for applying SOLO taxonomy in science, biology and chemistry are surveyed using pre-defined combination of Bloom’s taxonomy and Biggs and Collis’ SOLO taxonomy. This paper uses three approaches for analysis:

a) Teachers’ structured questionnaire and focus group interview

The teachers’ structured questionnaire is based on the 30 teaching strategies suggested by Alice Thomas at CDL (Thomas, 2010). The authors have categorized these strategies into the four Biggs and Collis SOLO taxonomy thinking levels. Other questions target the teachers’ stand on audio-visual resources and cooperative learning. Teachers are asked to complete the questionnaire and a focus group interview (mini-workshop) for all teachers from different disciplines is held to discuss the results of the survey and assessments analyses.

b) Student structured questionnaire:

The students’ structured questionnaire is a simplified version of the teachers’ questionnaire. Letters are sent to the parents to receive consent for their child’s participation in this survey. Whanau and classroom teachers ask students to complete the questionnaire.

c) Analyses of Y11-13 NCEA achievement standards assessments:

Formative and summative assessments of Y11-13 science, biology and chemistry are analysed using Blooms’ taxonomy and Biggs and Collii’s SOLO taxonomy. Percentages of correctly answered questions are calculated.

6. Results & discussion
The results and discussion focused on the following points:

a) What teachers think?

The results show that all science teachers at Tarawera High School are willing to explain the different thinking levels to their students. They acknowledge the importance of actively teaching students, metacognition to facilitate acquisition of skills and knowledge and to help students change from passive recipients to productive and creative generators of information. SOLO taxonomy represents an easy and a measurable tool that helps students assess their knowledge and thinking levels, Figure 2, shows the teachers’ percentages, (note that, 5 is strongly agree, 4 agree, 3 neither agree or disagree, 2 disagree, and 1 strongly disagree).

86% of the science teachers agree that developing a routine for teaching concepts can help students understand better. The teachers specify the following routine; (i) naming the critical features of a concept; (ii) naming additional features of the concept; (iii) giving best examples or prototypes of the concept; and (iv) identifying other similar or connected concepts. The same group of teachers agrees that presenting false features of a concept or giving non-prototypes should be only be
used once the students have reached the multi-structural level. This helps students connect ideas in preparation for relational thinking level.

Approximately 72% of the teachers agree that teaching question-answer relationships and the components of the learning process are effective strategies that help students understand their thinking levels. Teachers believe that students should be trained to evaluate their knowledge and thinking level through the skills needed to answer questions. Teachers should help students distinguish: (i) questions that have the answers right there; (ii) questions that need thinking and searching; (iii) questions that require reading and reflecting and (iv) questions that can be answered based on the student’s experience. This can be a successful tool during self and peer assessments. At early stages of implementation, teachers suggest to label the assessment questions to help students recognize different question types.

At the uni-structural level, all teachers of Y7-13 agree that they should focus the students’ attention towards the concepts taught. Teachers believe that they should identify key concepts clearly. All teachers believe that they should stress both the correct method of accomplishing a task and the correct answer. To help raise the thinking level of the students they must be shown different strategies to solve a problem or complete a task. Students should also be encouraged to select alternative methods to solve the same problem or approach a task. The teachers find it important to emphasize the difference between understanding and memorizing concepts. Teachers believe that memorizing can allow students to think at the uni-structural levels, but certainly does not support higher levels of thinking. This teaching strategy may not apply to highly dyslexic students that have to memorize to facilitate their learning.

At the multi-structural thinking level, 86% of all science teachers believe that identifying key concepts is an effective teaching strategy. 57% of the teachers believe that mastery of basic concepts is essential to proceed to more sophisticated concepts. The weak grasp of basic concepts leads students to misunderstanding, lack of confidence and inflexibility to apply knowledge. 71% of the teachers believe that they should lead their students in the process of connecting concepts, arranging concepts and creating concepts webs for more clarity. Teachers strongly believe that students should be asked to stop, compare and connect new information to things they already know. Only 43% of Y7-13 teachers recognize the importance of training students to categorize concepts into concrete, abstract, verbal, nonverbal or process, Y13 teachers feel more confident introducing the idea starting term 2. When discussing the issue with Y7-12 teachers, they all agreed that such training might overload both teachers and students.

55% of the teachers believe that moving from concrete to abstract and back to concrete can be a helpful teaching strategy. Further analysis showed that Y7-11
teachers feel that such practice has proved confusing to their students. Y12-13 students use this teaching strategy with careful planning. At the relational thinking level, all science teachers believe that having students involved in discussions of their school issues promotes higher thinking levels. Students should also be allowed to discuss issues in local and national news. Teachers believe that it is essential to have students relating new information to prior knowledge and concepts. Use of analogies, similes, metaphors and future applications of what they are learning is an effective means by which students can move towards deep understanding.

86% of the teachers believe that students should be encouraged to engage in elaboration and explanation of facts rather than repeating them. All teachers believe that concept mapping and graphic organizers are indispensable tools by which students can connect concepts and create a comprehensive concept. Whenever possible, teachers train their students to develop graphic organizers such as cycles, chains of events, fishbone maps, compare and contrast matrices, problem\solution outlines and KWLH. Teachers find graphic organizers form a good base for concept mapping. A concept map should be practiced as a collaboration effort between teachers and students that progresses as a unit or a chapter progresses.

At the abstract level, all teachers believe that most students will benefit from opportunities to develop their creative tendencies and divergent thinking skills. Teachers believe that developing a partnership with their students is important to help raising their thinking levels. This partnership allows the students to bring very practical and effective strategies to the table that the teacher may not have otherwise considered. All teachers believe that they should strive to provide lesson plans that allow analytical, practical and creative thinking activities. Encouraging questions and helping students identify problems according to all teachers is a successful tool by which they can encourage raising the thinking levels. 86% of the teachers reward their students for their original or “out of the box” thinking.

b) Effective teaching tools

85% of the teachers believe that students use diverse skills when understanding concepts. These aptitudes vary between being told, shown or allowed to practice concepts and mind visualize them. Y12 & 13 biology teachers find making mind movies of complex and detailed concepts such as DNA mechanisms and manipulation can be very helpful. Teachers believe that students must be encouraged to make visual representations of what they are learning. This includes drawing, constructing structures and making diagrams.

All teachers believe that students should practice problem identification and have them defend their responses. They identify cooperative learning groups as a powerful tool in problem identification. It allows students to listen and learn from the discussion of the group members. Cooperative learning assists students who exhibit
language challenges. It provides oral language and listening practice and results in an increase in the pragmatic speaking and listening skills of group members.

Teachers agree that cooperative learning requires careful planning, structuring, monitoring and evaluation to enable positive interdependence, individual accountability and social skills. Slow and progressive approach should be used to introduce cooperative learning. It should be guided and tasks should be clearly defined. Teacher should monitor every step of it. Teachers can start by assigning roles within each group. Roles can then be switched to allow students practice different roles. Students then can divide roles among themselves to increase their productivity as a group.

c) What students think?

The results as in Figure 3 show a minimum of 80% acceptance of Solo Taxonomy application through years 7-13 students at Tarawera high school. Students appreciate clearly defined learning objectives, emphases of clear concepts and lesson plans. Both years 7 and 8 students show a preference of the uni-structural thinking level. The preference of other thinking levels does not exceed 20% in Y7 students. This reflects a basic level of knowledge that teachers should build on using different teaching strategies to help enrich the knowledge of their students. Y8 students show 35% preference at the multi-structural level. This is a percentage that teachers should keep in mind to help extend this group into the relational level. Teachers need to be aware of the other thinking levels and help extend students with proper learning activities.
There is a prevalence of the multi-structural thinking/learning level throughout years Y9-Y11. This is an expected result, since the students have accumulated large amounts of knowledge. Yet they are unable to understand its significance or formulate it within a context. Graphic organizers and concept mapping can be a useful tool that teachers are encouraged to use within these year levels. Carefully designed formative assessments and diagnostic tests can easily identify the students within each level. Classroom activities should be directed towards each group of students to help solidify their knowledge and raise their thinking levels. 40% of year 12 students show a preference towards the relational thinking level. The participatory classroom approach suggested by many NCEA achievement standards have allowed the students to move to a deeper level of understanding. The students at this level are capable of connecting information and presenting its significance.

45% of Year 13 science students are capable of generalizing, theorizing and writing informed conclusions. The students have developed strong independent learning skills that enable them to conduct efficient research that can help solve problems. Audio-visual approach of science concepts and processes represents the most preferable among Y7-13 science students. Audio visual resources combine many have a Cooperative learning is gradually appreciated as students move from Y7 through Y13. It is clear that teachers in junior school need to put more effort to strengthen this teaching strategy among students.
d) Analyses of formative & summative assessments

Table 2, shows the results of analyses of several achievement standards at the science department at Tarawera High School.

<table>
<thead>
<tr>
<th>Year level</th>
<th>Subject</th>
<th>Achievement Standard</th>
<th>Uni-structural (%)</th>
<th>Multi-structural (%)</th>
<th>Relational (%)</th>
<th>Abstract (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Science</td>
<td>1.1(AS90930)</td>
<td>50</td>
<td>40</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1 Formative assessment</td>
<td>60</td>
<td>20</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Chemistry</td>
<td>2.1(AS 91161)</td>
<td>12</td>
<td>60</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.1 Formative assessment</td>
<td>40</td>
<td>40</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>2.1 (AS 91153)</td>
<td>8</td>
<td>70</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.1 Formative Assessment</td>
<td>5</td>
<td>80</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>13</td>
<td>Chemistry</td>
<td>3.1 (AS 91387)</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.7 (AS 91393)</td>
<td>8</td>
<td>22</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Biology</td>
<td>3.1 (AS91601)</td>
<td>--</td>
<td>--</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>level 3</td>
<td></td>
<td>3.7 (AS91607)</td>
<td>10</td>
<td>10</td>
<td>60</td>
<td>20</td>
</tr>
</tbody>
</table>

Upon examining several NCEA formative and summative assessments, it is clear that Y11 are at the uni-structural to multi-structural level. The majority of year 12 students are at the multi-structural level. Y13 students are spread among the relational and abstract thinking levels.

7. Conclusion

There is a solid understanding of the importance of applying Biggs and Collis’ SOLO taxonomy within the science department at Tarawera High School. At the relational level, students should be able to either break a concept or link it to another by identifying similarities and differences. In early stages, this activity can start by direct listing of the similarities and dissimilarities. Students’ involvement in this activity can be promptly incremented. At later stages, students can be asked to identify the similarities and differences on their own. This will certainly encourage variation and broaden understanding. Venn diagrams, graphic organizers and concept maps are successful tools of this strategy. This strategy is constantly applied in Biology level 2 NCEA lessons and formative assessments

Peer assessment is considered an effective means by which students can enhance their thinking levels. Before marking the Level 3 NCEA biology Biotechnology, the teacher discussed the low excellence NZQA exemplar and asked the students to assess their peers. Two 75 minutes lessons were assigned for this activity. The
students then held an open discussion to ask for clarifications. This approach proved successful in helping the students acquire a deep level of understanding (Rana & Tarik). It is rather essential that the SOLO taxonomy terminology is addressed in class as an integral part of every lesson. The goals and learning objectives of each lesson as well as the whole unit should be clearly defined. Guided mini-activities may continue introducing new ideas while re-enforcing the SOLO taxonomy terminology similar terminology should exist within every formative assessment. Upon completion of every assessment, time should be assigned to

The students’ goal should be to help move to the upper level within each achievement standard. It is the effective planning and conducting of lesson plans that integrate the SOLO taxonomy within active participatory classroom that enables students to raise their teaching and learning levels of the students.

Cooperative and Inquiry based learning is a successful and inviting tool by which students can move to the abstract thinking level, where they can generalize and make informed conclusions. Teachers should step back and allow students to ask questions, find answers, evaluate them and reach conclusions. This allows students to develop critical thinking skills and tools that they can apply within the 21st century.

Uni-structural solo taxonomy: Students are able to make simple connection but cannot note any significance. The student does not have a full understanding of the concepts and simply states them or writes them down. At the relational level, students should be able to either break a concept or link it to another by identifying similarities and differences. In early stages, this activity can start by direct listing of the similarities and dissimilarities. Students’ involvement in this activity can be prompted incremented. At later stages, students can be asked to identify the similarities and differences on their own. This will certainly encourage variation and broaden understanding. Practical investigations represent a great tool for raising the thinking level of the students. All the analysed assessments were practical investigations or inquiry based assessments. The students’ potential to raise their teaching and learning levels becomes higher.

SOLO taxonomy posters must be hung in classrooms. Suggestions by researchers Practical investigation assessments of levels 2-3 Biology and Chemistry, requires the students to submit a draft. Based on predefined criteria, the students are also required to write the areas where they would like feedback for improvement. This ensures students’ ownership of their own learning (Marie Baehr). Generating and testing hypotheses is considered a powerful means by which students can improve their thinking learning levels. Students appreciate hands-on experiences and engage more when are in charge. The road map is a successful means by which the teacher can introduce more learning objectives. Conclusion: Active classroom participation+ Cooperative learning + SOLO taxonomy.
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