CONSTRUCTIVIST ASSESSMENT APPROACHES IN SCIENCE PRE-SERVICE TEACHER EDUCATION PROGRAMME

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Constructivist assessment approaches are based on the basic principles of the theory of constructivism. According to constructivism, learners construct knowledge through observation, experience, documentation, analysis and reflection (Dogra, 2010). According to the constructivist perspective, teaching or rather more precisely learning of science is not a search for the ultimate truth. It is a process which is of utmost importance in science than the content (Dogra, 2010). Assessment from constructivist perspective is a holistic process, which includes both content as well as process. Constructivist assessment is based on the collaborative activities of a teacher as well as learners. Constructivist assessment is subjective because it makes use of different qualitative strategies rather than quantitative ones. For implementing constructivist assessment approaches, the teacher needs to know the students well. This paper exemplifies how different constructivist assessment approaches can be used in science pre-service teacher education programme. The use of various constructivist assessment approaches, like roleplay, story writing, concept maps, student presentations and poster projects in school life experience comprise the pre-service teacher education programme of the Army Institute of Education, Delhi Cantonment (a B.Ed. college affiliated to the I. P. University), which find a detailed mention in this paper. Pre-service science teachers designed constructivist assessment tasks in collaboration with the author. Some of the examples of constructivist assessment approaches experienced by secondary school science students are presented in this paper. This paper exemplifies how assessment forms an integral component of learning and also an enjoyable and fun-filled activity for both pre-service science teachers as well as school students. Pre-service science teachers felt that such assessment approaches made students involved in their assessment and shifted the focus from tests to more subjective assessment tasks.

Introduction

"We should be measuring what kids can do with knowledge, not how many right answers they can give to questions."

—Seymour Papert

What is the purpose of assessment? Teachers transact curriculum through different methods and need assessment techniques to monitor the progress of students. Assessment also provides feedback to teachers about the effectiveness of their own teaching. In the last several years,

a lot has changed in the field of assessment. There is a major shift from 'outcome-based assessment' to 'assessment for learning'. Assessment tasks can be designed, which can assess understanding. This has also made assessment approach completely student-centred and humanistic. There is a lot of emphasis on designing assessment tasks, keeping in view the constructivist theory. Constructivist theory forms the basis for designing meaningful assessment practices. Constructivism is unique because it focuses on developing the learners' knowledge by constructing the world around them through experience, observation, documentation, analysis and reflection. In today's classrooms, learners are no longer passive recipients, nor are teachers 'the experts of knowledge", i.e., people who know everything. According to constructivist view, the learner is a sense-maker, whereas, the teacher is a cognitive guide or a facilitator who provides guidance and modelling on authentic academic tasks. The teacher's role is to create environments, in which the learner interacts meaningfully with academic material, including fostering the learner's processes of selecting, organising and integrating information.

The NCF (2005) recommends five guiding principles for curriculum construction. They are:

- connecting knowledge to life outside school,
- ensuring that learning is shifted from rote methods,
- enriching the curriculum to provide for the overall development of children rather than remaining textbook-centric,
- making examinations more flexible and integrated into classroom life, and
- nurturing an over-riding identity informed by caring concerns within the democratic polity of the country.

These can also be the guiding principles for the evaluation process. The researcher motivated the pre-service science teachers to use different constructivist evaluation methods, like roleplay, logbooks, storytelling, concept maps, cartoons, presentations, poster projects and project work while teaching secondary school students. This paper discusses only five constructivist evaluation methods used by pre-service science teachers of the Army Institute of Education. It not only discusses different science topics assessed through these constructivist methods but development of criteria for the assessment for each method through collaborative effort between the author and pre-service science teachers. It presents collaborative assessment experiences of the pre-service science teachers as well as the author.

Assessment from a Constructivist Perspective

Assessment and evaluation in a constructivist environment should focus on the students' ability to "organise, structure and use information in context to solve problems" (Osberg, 1997). Brooks and Brooks (1993) describe what assessment in a constructivist classroom looks like. Whenever a constructivist teacher does not get an expected answer from the students, then instead of replying in the negative, the teacher tries to understand the thinking of the students. Then, the teacher helps the students to construct new knowledge and acquire new skills by asking non-judgemental

questions to them. Generally, assessment is done to find out what the children know and what they do not. It should be treated as an important tool for improving students' understanding and teachers' understanding of students.

Constructivist learning is an active process and alternative assessment celebrates this process. In alternative assessment, the focus is on providing non-traditional means that allow students to show their understanding of a concept or process. It is also a complex and holistic approach to assessment. Alternative assessment techniques, such as criterion-referenced and performance-based assessment relate strongly to real world experiences (Rose, 1995 and Resnik, 1989). It is not easy to develop or administer performance-based or other alternative assessment procedures (Herman, Aschabacher and Winters, 1992). It requires more time and stronger bonding between the teacher and the learners.

We are discussing here the role of some non-traditional methods in science assessment of learners.

1. Roleplay as a Constructivist Assessment Approach

What is Roleplay?

Roleplay is an unrehearsed dramatisation, in which individuals improvise behaviours that illustrate acts expected of persons involved in defined situations. Teachers can encourage their students in roleplay activities by presenting realistic or hypothetical situations. The students can, then, list different characters and improvise dialogues and actions to fit the requirements of the situation and the character they are playing.

In successful roleplays, students understand the information provided about their role and then enact the given role in a fictional situation.

Roleplay in Constructivist Assessment of Learners

Roleplay helps teachers to find out to what extent students have understood the concept taught in the class. Students can put up a roleplay in case they have understood the concept thoroughly. They cannot put up a roleplay just by rote memorisation of the concept. It requires assimilation on their part and then demonstrating their level of understanding in a realistic or hypothetical situation related to the concept. Even difficult topics can be presented through roleplay in a holistic manner. Roleplay helps the students to understand the concept in a better way because they work on their own individually as well as in a group for playing their respective roles. Creating a roleplay is not an easy task and a creative mind is needed for this purpose. The outcome of this act is fruitful and creates enthusiasm.

In Box I, a roleplay on 'Global Warming' is discussed in detail. But there are other topics in science, in which roleplay can be used for constructivist assessments, such as:

- food chains, food webs where different, human's trophic levels can be depicted.
- the process of digestion in humans, and
- the process of transportation of water in plants.

Criteria developed collaboratively by pre-service science teachers along with the author

Roleplay on 'Global Warming'

(i) Amount or level of knowledge imparted through a roleplay. This requires answering questions, like:

Global Warming

Oxygen and Carbondioxide gases are talking to each other. They started discussing the issue of global warming. One student plays the role of Oxygen and the other plays the role of Carbondioxide and the third student plays a human being. The moderator introduces the roleplay to the audiences

Oxygen (O_2): Hello CO_2, how are you?

Carbondioxide (CO_2): Hello O_2, I am good.

O_2: Yes, why you should not be good? You are increasing in quantity day-by-day.

CO_2: O_2, thanks to this human community for this. They burn fossil fuels, cut trees and do many other things which increase my quantity.

O_2: Oh! I know that and I also know that increase in your amount leads to an increase in the earth's temperature.

CO_2: Yes, this is the saddest part of the story. I am increasing, and hence, the temperature of the earth is also increasing.

O_2: But how come you are responsible for that.

CO_2: Look O_2, my primary function is trapping outgoing sunlight/sun's radiation which gets reflected from the earth's surface.

O_2: Okay, so your increased amount leads to increased trapping of outgoing sun's radiation.

CO_2: And the atmosphere of the earth gets overheated leading to an increase in its temperature. This is called global warming.

O_2: So, ultimately, humans are responsible for this global change. I think they should take some preventive measures.

Human being enters the room and turns towards O_2 and CO_2.

Human being: Well, humans have signed many treaties and agreements.

O_2: What kind of treaties and agreements have been signed by you?

Human being: Apart from CO_2, methane, nitrogen oxides, etc., also lead to global warming. Therefore, countries have signed agreements and treaties, wherein they promise to cut down the emission of such gases also called greenhouse gases.

CO_2: Yes, human beings must reduce the emission of greenhouse gases. The increase in the earth's temperature by less than 10 will lead to the melting of ice caps and the sea level will rise.

O_2: This will also lead to the sinking of coastal areas.

CO_2: Yes, correct. Ecological shift will also take place.

O_2: But CO_2 something should be done to prevent global warming.

CO_2: Yes, something should be done but it is not you or me that can do anything about global warming. The human beings, who are responsible for the problem, should take preventive measures.

O_2: What preventive measures?

CO_2: We have human beings here; let us ask them what they would like to do on individual basis to reduce global warming.

- What is global warming?
- What are the various reasons for global warming?
- What measures should be taken to reduce global warming?
- What day-to-day measures can be taken by common man for reducing global warming?

(ii) Level of creativity used in imparting or expressing knowledge related to the topic includes—

- Characters from day-to-day life.
- Manifestation of non-living.

(iii) Development of script—

- Script to be of 3-5 minutes.
- Proper organisation of the script.

(iv) Dialogue delivery—

- Appropriate voice modulation.
- Correct pronunciation of words.
- Fluency in the language chosen for roleplay.

(v) Types of props used—

- Maximum utilisation of easily available resources.

(vi) Conclusion/culmination/end of roleplay—

- The end of the roleplay should be thought-provoking.
- If not thought-provoking, the culmination of the roleplay should have a slogan or message.
- Extra weightage will be given for involving audiences in the roleplay.

2. Story Writing/Pictorial Story as a Constructivist Assessment Approach

Everybody loves stories. If we recall our childhood days, then we can remember the stories narrated by our grandparents. Many a time, pre-service teachers are tempted to introduce a lesson by narrating a story. Why do pre-service teachers use stories in their teaching? This is because a good story is not only entertaining but is also capable of holding students' attention while they learn important concepts, attitudes and skills.

According to McClintock (2004), personal stories are useful for assessment because of their following attributes:

- Storytelling lends itself to participatory change processes because it relies on people to make sense of their own experiences and environments.
- Stories can be used to focus on particular interventions while also reflecting on an array of contextual factors that influence outcomes.
- Stories can be systematically gathered and the claims can be verified from independent sources or options.
- Narrative data can be analysed using existing conceptual frameworks or assessed for emergent themes.
- Narrative options can be integrated into ongoing organisational processes to aid programme planning, decision-making and strategic management.

Objectives of Water Cycle Story (Text-based and Pictorial)

Students will be able to—

- define evaporation.
- define transpiration.
- list different sources of water.
- explain the process of condensation.
- explain the different states of matter.

Evaluation on the Basis of Story

A rubric was developed keeping in mind the following characteristics—

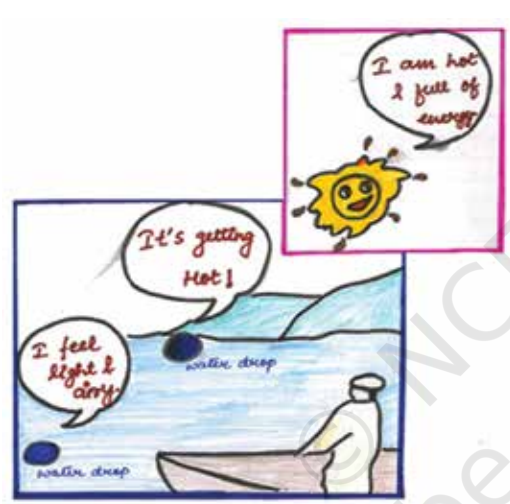
- interesting

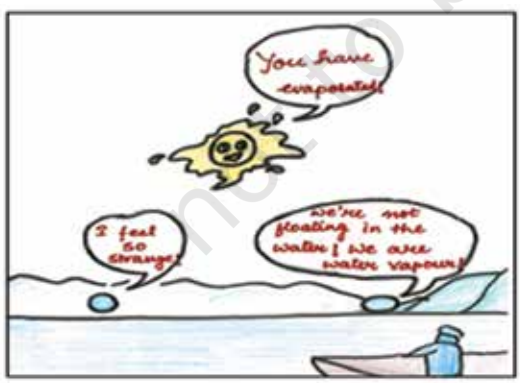
- related to the topic
- achievement of objectives
- language used in the story
- text/pictorial depiction

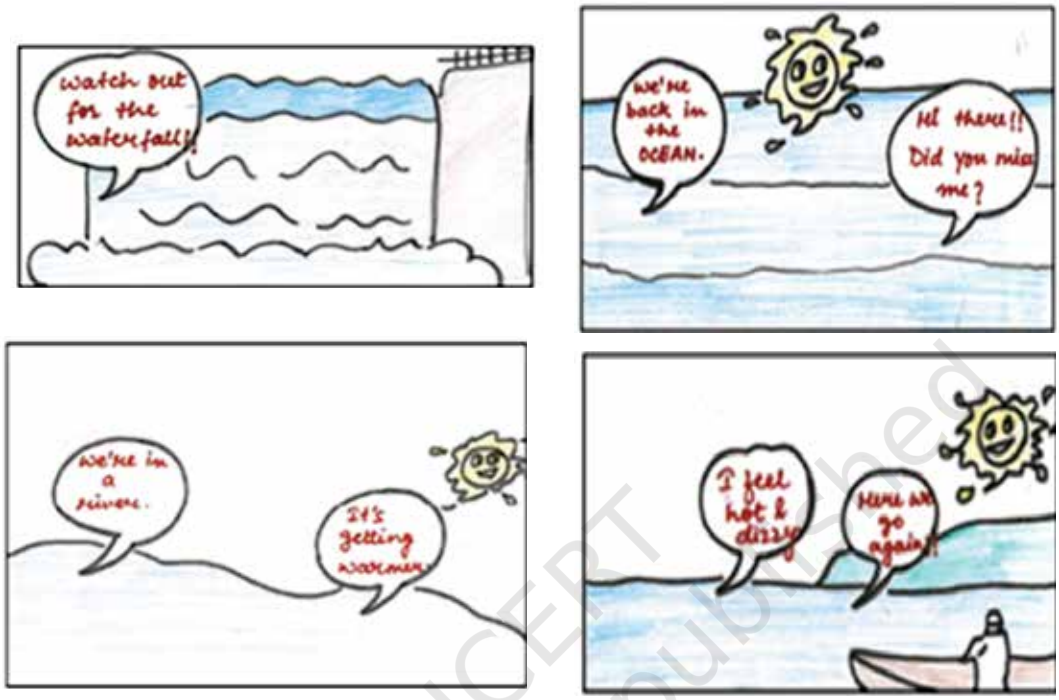
What are Rubrics?

A rubric is a particular format for criteria—it is the written version of the criteria, with all score points described. The best rubrics are worded in a way that covers the essence of what all teachers look for when they are judging quality and they reflect the best thinking in the field as to what constitutes good performance. Rubrics are frequently accompanied by examples (anchors) of products or performances to illustrate the various score points on the scale (Arter and McTighe, 2007).

Pictorial representation of the Water Cycle







Story of Water Cycle

Let us find out what will happen to the two water drops. The water cycle story starts as the sun looks down on the two water drops. The sun is full of energy and in its presence, these water drops start feeling hot, light and airy. The sun's heat provides energy to water to evaporate from the Earth's surface (oceans, lakes, etc.). The two drops of water feel strange because they feel as if they are floating in the air. They realise that they have now become vapours. Why? Because evaporation occurs when heat is placed on water. It becomes warm enough to change into gas. But what is water vapour? Water vapour is nothing but water in its gaseous state and we get water vapours through the processes of evaporation and transpiration. Now, these two drops of water in the gaseous state start rising higher. At a height, they get cooled and then condense. Now, what is condensation? Condensation is the cooling of vapours until they acquire a liquid state. As the dew point is reached, water vapours form tiny visible water droplets. Then these droplets form the clouds. droplets are now happy that they are a part of the beautiful cloud. Further cooling takes place and the droplets are now part of the snowfall. The droplets turn into snow and talk to each other. One says I have turned into snow and hate to be part of this water cycle. The other replies that now we are stuck on a glacier i.e., a river of ice. Gradually, they both become part of the river and finally end in the sea. Oceans are the largest source of water. So, water cycle is a continuous process. The water cycle which we discussed today, is the same that was present when dinosaurs roamed on the earth.

3. Concept Maps for Constructivist Assessment

"Concept maps are intended to represent meaningful relationships between concepts in the form of propositions. Propositions are two or more concept labels linked by words in a semantic unit. In its simplest form, a concept map would be just two concepts connected by a linking word to form a proposition. For example, 'sky is blue' would represent a simple concept map forming a valid proposition about the concepts 'sky' and 'blue' ".

—Joseph Novak and Bob Gowin from Learning *How to Learn*

According to Novak (1984), concept maps work to make clear to both students and teachers the small number of key ideas they must focus on for any specific learning task. A map can also provide a kind of visual roadmap, showing some of the pathways we may take to connect meanings of concepts in propositions. After a learning task has been completed, concept maps provide a schematic summary of what has been learned.

There are many criteria for the assessment of concept maps. Concept maps can be assessed through rubrics. Bartel's scoring rubric as well as scoring criteria for concept maps (Novak and Gowin, 1984) find a detailed mention in this paper.

Bartels' Scoring Rubric for Concept Maps

Concepts and Terminology

3 points show an understanding of the topic's concepts and principles and use appropriate terminology and notations.
2 points make some mistakes in terminology or show a few misunderstandings of concepts.
1 point makes many mistakes in terminology and shows a lack of understanding of many concepts.
0 point shows no understanding of the topic's concepts and principles.

Knowledge of Relationships among Concepts

3 points identify all important concepts and show an understanding of the relationships among them.
2 points identify important concepts but make some incorrect connections.
1 point makes many incorrect connections.
0 point fails to use any appropriate concept or connections.

Ability to Communicate through Concept Maps

3 points construct an appropriate and complete concept map and include examples, place concepts in an appropriate hierarchy and place linking words on all connections; produce a concept map that is easy to interpret.
2 points place almost all concepts in an appropriate hierarchy and assign linking words to most connections; produce a concept map that is easy to interpret.
1 point places only a few concepts in an appropriate hierarchy or uses only a few linking words; produces a concept map that is difficult to interpret.
0 point produces the final product that is not a concept map.

Concept maps of children can be scored easily. According to Novak and Gowin, the primary basis of scoring scheme is Ausubel's cognitive learning theory, especially three ideas in it:
(1) Cognitive structure is hierarchically organised, with more inclusive, more general concepts and propositions subordinate to less inclusive, more specific concepts and propositions, (2) Concepts in cognitive structure undergo progressive differentiation, wherein greater inclusiveness and greater specificity of regularities in objects or events are concerned and more propositional linkages with other related concepts are recognised, and (3) Integrative reconciliation occurs when two or more concepts are recognised as relatable in new propositional meanings and/or when conflicting meanings of concepts are resolved.

Scoring Criteria for Concept Maps (Novak and Gowin, 1984)

1. **Propositions**
   Is the meaningful relationship between two concepts indicated by the connecting line and linking word(s)? Is the relationship valid? For each meaningful, valid proposition shown, score 1 point.

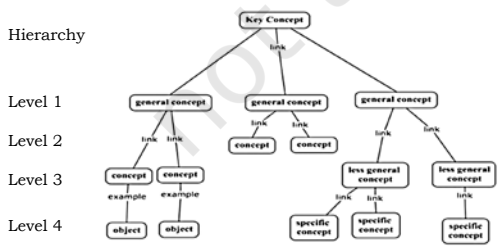


Fig. 1: A typical concept map showing relationships, hierarchy and cross links

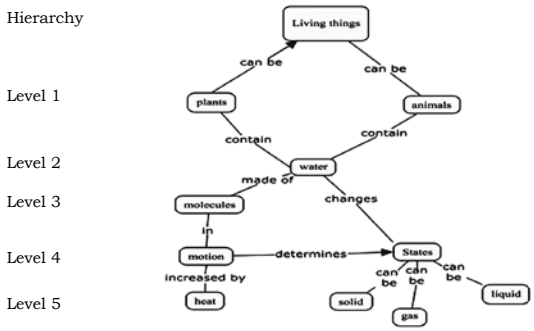


Fig. 2: A concept map for water showing some related concepts and propositions

2. **Hierarchy**
   Does the map show hierarchy? Is each subordinate concept more specific and less general than the concept drawn above it (in the context of material being mapped)? Score 5 points for each valid level of the hierarchy.
3. **Cross links**
   Does the map show meaningful connections between one segment of concept hierarchy and another segment? Is the relationship shown significant and valid? Score 10 points for each cross link that is both valid and significant and 2 points for each cross link that is valid but does not illustrate a synthesis between sets of related concepts or propositions. Cross links can indicate creative ability and special care should be given to identifying and rewarding its expression. Unique or creative cross links might receive special recognition, or extra points.
4. **Examples**
   Specific events or objects that are valid instances of those designated by the concept label can get a score of 1 point each. (These are not circled because they are not concepts).

5. In addition, a criterion concept may be constructed and scored for the material to be mapped, and the student score can be divided by the criterion map score to give a percentage for comparison.

Scoring Model

Scoring for the model is given below:

Relationships (if valid)	= 12
Hierarchy (if valid)	= 20
Cross links (if valid and significant)	= nil
Examples (if valid)	= 04
Total Points	**36**

Let us take an example of a concept map of water for understanding the assessment of concept maps.

Relationships (if valid)	= 12
Hierarchy (if valid)	= 25
Cross links (if valid and significant)	= 10
Examples (if valid)	= nil
Total Points	**47**

4. Student Presentations (individual/group)

Student presentations are frequently assessed and may be awarded a percentage of the marks. At times, we have witnessed that under the pressure of assessment, students become nervous and are not able to present well. Therefore, if a teacher decides and conveys to students that some presentations are not to be assessed, then such opportunities can enhance their presentation skills. But what will be the drawback of introducing assessed presentations along with non-assessed presentations? This will motivate students to invest all their time and effort on assessed presentations with little or no effort on non-assessed presentations. As teachers realise that the entire thrust of students is on marks/grade earned rather than learning from the entire experience, they shift back to only assessment-based presentations.

The use of assessment can have a positive advantage. For some students, presentations offer opportunities to score higher marks than they might achieve for a written test. Such students may exhibit better communication and presentation skills along with the use of technology than presenting it through the written mode. Such students may need suggestions for content rather than upgrading their presentation skills. Students presented individually/collectively on several topics of science. They made use of posters, bulletin boards, charts, hand outs, newspaper cuttings and power-point presentations. Some of the topics selected by the students were: a typical cell, respiration, living world, habitat, blood circulation, etc.

Criteria for Assessment

- Comfort level
- Attending presentations of other students. Give feedback, citing if it was—
  - ✓ a good learning experience.
  - ✓ interesting.
- Content coverage
  - ✓ Cover all objectives related to content
  - ✓ Interesting introduction
  - ✓ Use of good and relevant examples
  - ✓ Making it simple and understandable
  - ✓ Relating it to current or day-to-day events

- Aids used (newspaper cuttings, posters, bulletin boards, charts)
  - ✓ Making understanding better
  - ✓ Making it more colourful
  - ✓ If done collectively, then each member of the group was involved
  - ✓ Relevant
- Power-point presentation
  - ✓ Good presentation
  - ✓ Lucid explanation
  - ✓ Clear communication
  - ✓ Individual/group work
  - ✓ Use of examples

5. Poster Project

A poster presentation is "an experiential learning activity that stimulates curiosity and interest, and encourages exploration and integration of concepts and provides students with a novel way of demonstrating understanding" (Handron, 1994, in Bracher; Cantrell and Wilkie, 1998). Students can present posters individually or collectively for the purpose of assessment in science teaching-learning process.

Pre-service science teachers assessed students knowledge after finishing a lesson or unit by giving them a task of poster making. With some basic art supplies and poster boards or papers, students were given an opportunity to create a visual display detailing some aspects of the lesson. At times, pre-service teachers imposed limitations to the poster, such as listing at least five facts learned. Poster presentation not only provides a great opportunity to assess students' knowledge, but it also provides a great display to students outside the classroom. The assessment of the posters was done mainly on the basis of three main criteria:

- **Process**
  It included planning (individual/group effort), dividing the time for each task of the project, collaborating with the team members (if group work), division of work, team leadership and group work.
- **Final Product**
  - ✓ Visual impact/communication of the poster.
  - ✓ Content knowledge displayed.
- **Verbal Communication**
  It is the verbal explanation of poster by the individual/group members.

Conclusion

The use of five constructivist approaches— roleplay, story writing, concept maps, student presentations and poster projects in secondary school science teaching-learning process by pre-service science teachers is an effort to deviate from the traditional method of testing students in classrooms. These pre-service science teachers, having experienced paper and pencil test during their school days, were not satisfied with the most common assessment method used at the end of each instructional unit. Therefore, they experimented with alternative ways for assessing the students. As Price and Hein point out, current views of how students learn and how they express their thinking have opened the way to new methods of assessment. In these constructivist

assessment approaches, pre-service science teachers could assess reasoning of their students; provide opportunities to students to engage in the ongoing assessment of their learning along with their peers. These approaches diluted the boundaries between classroom life and examination, which is supported by constructivism. But pre-service science teachers also faced many challenges in terms of choosing a particular assessment approach, keeping in mind the nature of the topic and the level of students. All constructivist assessment methods cannot be used for all types of science topics. Teachers need to plan and select different constructivist assessment methods based on their experiences and understanding of students. Therefore, initially, tests can be combined with these new assessment approaches and topics can be selected accordingly. Gradually, the system of constructivist assessment methods can be further improved through experience and feedback received from students.

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