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Research Paper

Creative education for the improvisation of experimental teaching materials for training qualified biology teachers

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Abstract. The core objective of the research was to improvise unconventional teaching materials from locally available resources and employ for experimental biology lesson delivery processes in training qualified biology teachers. The research populations were 24 trainees of biology PGDT that used creative education to improvise supportive teaching materials and used for the delivery processes of both purposive "identifying the acidity or basicity of solutions" and five various referenced experimental biology lesson topics. Trainees used improvised experimental teaching materials for lesson delivery processes through peer teaching and the effectiveness of performances and experience construction was measured through observation checklists composing of data collections variables identified using quasi-experiment methods. Performance effectiveness of biology trainees on of purposive and referenced lesson delivery process conducted through peer-teaching was assessed using Likert scale of 10% levelled scoring systems. As a result, the average performance effectiveness and experience construction scored through conducting peer-teaching of trainees was 82.5% in training productive and effective qualified biology teachers. The research was concluded by the fact that creative education is helpful in improvising proper teaching materials and enhanced in mind mapping and constructing basic concepts both theoretically and practically and supported learners in understandable and doable conditions of the prescribed curricula and designated contents and beyond.

Keywords: Acidity, basicity, creativity, divergent thinking, litmus, lemon juice.

INTRODUCTION

Creative education is one the contemporary educational models used in every subject to solve complex problems of ineffective and defective teaching methods and improve the educational systems (teaching, learning and assessments). It is the ability to use imagination and critical thinking and create new and meaningful forms of ideas through independent, flexible and manners.

The role of creative education is synthesizing new concepts and scientific information to improvise usable materials to serve either in education systems or daily faucets of life style of human being for all required aspects.

In fact, the secret of creating new ideas depends upon separating divergent thinking from convergent thinking so that creativities are limited to only little access.

Divergent thinking is a thought method used to generate creative ideas by exploring many possible solutions whereby convergent thinking follows a particular set of logical steps to arrive at one solution (Wikipedia, the free encyclopaedia, 2017).

Thus, creative education is the one that comes up with various alternative solutions through divergent thinking to construct new skills that enhance in generating immerse of options of improvising useful teaching materials that typically occur in a spontaneous, free lowing and non-linear manner of which many ideas are generated in an

emergent cognitive fashion.

According to Yong (2013), creativity is the ability to identify new solutions to problems within one's own specific context and skills associated with problem solving, convergent and divergent thinking, collaboration and resilience.

Creative education more or less contains problem solving creative ideas formed through mind mapping and improvising hitherto undiscovered learning tools for both teachers and learners from locally available or accessible materials. It is sometimes called design education that may not be confused with education pertaining to the design industry.

On the other hand, scientific problem solving method is a more explicit form of cultivating creativity through divergent and convergent thinking skills, which are more obvious ways on how to critically approach classroom activities, assignments and investigate more solutions of learning. Learning concepts include personality openness to experience and conscientiousness, intellectual strengths of problem solving, memory and knowledge retention, motivation and past experiences (http:www. scirp.org/journal/ce, 2013).

Creative thinking skills for idea generations, evaluation and recapitulation for mastery of the subjects dealt with are important parts of investigations that support learners in developing the concepts of creativity to improvise educational materials usable teaching biology to construct knowledge with the best mixes of diverse activities at all levels.

Divergent thinking, converging thoughts and developing ideas to produce sorts of supportive learning resources makes the subjects more understandable, doable, interesting and arrests the attention of students. Instead of being taught to reiterate what was learned in schooling systems, trainees of biology teaching need criticality in thinking to develop skills of finding solutions to problematic issues of education systems and grasp lifelong serving new ideas.

Constructing the skills of viewing facts through creative education to develop ideas, scale up the practicality of learning by doing with long retention capacity are contemporary modalities required in training biology teachers under the program of Postgraduate Diploma in Teaching (PGDT) of Addis Ababa University.

Accordingly, the roles of originating ideas to construct skills of crafting and improvise new usable teaching materials and employing for the delivery process of experiment-based biology lesson topics for training biology teachers through peer-teaching was preferred as the right truck to fix needed experiences.

MATERIALS AND METHODS

Materials

Research materials are improvised supportive teaching tools improvised from locally accessible resources and designated to be used for the delivery processes of biology lesson topics.

Methodological strategy was to engage 24 trainees of biology PGDT in conducting peer-teaching on experimental and non-experimental selected biology lesson topics. Consequently, 6 trainees preferred to conduct peer-teaching on experiment-based and the rest 18 on non-experimental biology lesson topics that the experiment based biology lessons were set into one purposive and five referenced topics installed into two tables as variables of evaluation. Brainstorming was provided to orientate trainees on how to improvise and employ teaching materials and resources for using in the delivery processes of experiment-based biology lesson topics through peer-teaching.

Methods

An overt observational research method was used to collect data on the performance effectiveness of using improvised teaching materials for the delivery process of both purposive and referenced experimental biology lesson topics and the practitioners were explained that the purpose of observations was for being a good biology teacher through conducting peer-teaching.

It was preferred for its advantage of fidelity and avoiding deceptiveness of research data. However, the hawthorn effect or portraying ideal self than true self could be minimized by means of detail lists of contents of observational variables and scoring mechanisms to find the true self of each trainee cross over preparations. For all biology lesson delivery process of peer teaching, student-cantered or student-led and teacher guided teaching methods were used.

Purposive experimental lesson delivery methods

Lesson topic: Identification of acidity and basicity of a solution

Materials: Printing paper, fine ash solution, lemon fruit juice, bluish purple flowers (*Ipmea purpurea L.*), two beakers, scissors and water.

Procedures: The blue litmus was made from strip print paper cut coated by a bluish purple flower whereby the lemon fruits juice was used as acids and fine ash solutions as bases. When coated strip paper was immersed into the lemon juice to identify the acidity and basicity of the solution, it turned red the colour showing the property of acidity. Similarly, when another coated strip paper was immersed into the fine ash solution, it turned it blue lack indicating the property of basicity.

Results: blue litmus paper, acids and basis, test tools

Table 1. Effectiveness of lesson delivery process on acidity and basicity of a solution.

Variables of measurements	Scores on performance effectiveness (10%)										
	1	2	3	4	5	6	7	8	9	10	Score
Substance clarity at beginning						*	*	*			7
Concept mapping level						*	*	*	*		7.5
Minds-on hands-on engagements					*	*	*	*	*	*	9
Scaling up skills of understanding							*	*	*	*	9
Enhancement of practical activity							*	*	*	*	9
Knowable construction effect							*	*	*		8
Average											8.1

were made from locally available materials and the acidity and basicity of substances were identified.

The variables set in the observation checklists composed of substance clarity, concept mapping levels, minds-on hands on engagements, scaling up skills of understanding, enhancement of practical activities and concept construction effects were practically measured.

In the process of biology lesson delivery on identification of acidity and basicity of solutions, trainees improvised **litmus paper**, acids and basis to test whether the solution is acidic or basic from locally available materials. Indeed, litmus is a water-soluble mixture of different dyes and pigments in blue that reacts with hydrogen ions and changes chemically and the bonds turn to reflect a longer wavelength of light to appear **red** to our eyes.

Consequently, citric acid, which is a weak organic acid collected from lemon fruit juice containing high concentration of acids (8% of the dry weight of the fruits) was used that turned blue litmus red under acidic conditions.

Subsequently, fine wood ash was applied as components of stabilized base solution that when applied turned the red litmus to blue under base (alkaline) conditions that was also improvised.

Hence, trainees completed learning of the purposive experiment-based biology lesson topic to high performances and concluded with understandable and doable qualifications.

Data were collected through observation checklist components set to compose of 10% levelled scores of Likert scale to measure the effectiveness of performances and utilities of improvised materials for the delivery process of purposive experimental biology lesson topic (Table 1).

Referenced experimental lesson delivery methods

Lesson topic 1: Osmosis in potato cells

Materials: Potato prism cuts, salt, two glasses, water, knife

Procedures: Two equal potato prism cuts were immersed into two glasses of pure water and highly salts concentrated were made to stay for observation of changes in both potato prism cuts for 2 hours on a table in the classroom.

Results: The potato prism cut immersed in the salt concentrated solution changed colours into dark brown and faded softy body that shapes shrunk and loose physical structure showing the loss of water by which the molecules of the solvent passed through a semipermeable membrane from a less concentrated solution into a more concentrated one and trainees completed the lesson with successful conclusion.

Lesson topic 2: Diffusion in liquids

Materials: Two tea glasses containing hot and cold water, coloured liquid

Procedures: coloured liquid were dropped onto two tea glasses containing hot and cold water simultaneously and the rate of time taken for dispersals of the drop of colour liquids in both glasses was watched and measured promptly.

Results: The dispersion rate was faster in hot than in cold water making clear of the concept.

Lesson topic 3: Identification of the positions of stomata on leaves

Materials: Trees with leaves, Vaseline, threads with two colours

Procedures: Two leaves of the same age and healthy physical structures were selected from a branch of a standing tree and the stalk of a leaf coated the upper side was tied by red and a leaf coated at the underside by white threads for identification and made to stay under observation of changes for 7 days.

Results: The leaf coated at the underside died, but the

Table 2. Effectiveness of lesson delivery process on five various lesson topics.

Experiment-based lesson topics	Scores on performance effectiveness (10%)										Score
	Understanding					Practicing					
	1	2	3	4	5	1	2	3	4	5	10%
Osmosis in potato cells				*	*				*	*	9
Diffusions of colours in cold-hot water			*	*	*				*	*	8.5
Identifying stomata position on a leaf			*	*	*			*	*		7.5
Leaf transpiration through plastic bags				*	*				*	*	9
Test for starch using iodine			*	*	*			*	*	*	8
Average											**8.4**

leave coated at the upper side remained without any change indicating that stomata are found at the underside of leaves.

Lesson topic 4: Leaf transpiration

Materials: a standing plant with leaves, plastic bag, thread, water gauge

Procedures: a small branch of a tree with leaves was covered by a plastic bag and the stalk was tied airtight with threads and observed for upcoming water output of the plant for 36 hours of daylight.

Results: the plastic bag was filled with water, which was gauged and recorded as per hour.

Lesson topic 5: Test for starch

Materials: Iodine, potatoes, a knife, pieces of bread

Procedures: each trainee who had a potato slice and a dropper with iodine solutions in hand were told to drop the iodine solution onto the potato slice and simultaneously on pieces of breads.

Results: potato slices as well as the pieces of bread subjected to the drop of iodine were turned blue lack proving test for starch.

The delivery process of the referenced experimental biology lesson topics of biology PGDT trainees was assessed on the basis of skill of understanding and practicing improvised teaching materials in conducting peer-teaching using observation checklists composing of variables of scoring levels of Likert scale and organized (Table 2)

Accordingly, for each of 5 experimental biology lesson topics, the practitioners used creative teaching aids and conducted the peer-teaching task through which both the understanding and practicality skills and concepts of each trainee peer teacher and role player were evaluated and its average was recorded.

Data analysis and evaluation

Data analysis and evaluation on performance effectiveness of teaching purposive experimental biology lesson topic conducted by one of the trainees was assessed through face-to-face observation checklist.

The checklist composed of variables dealing with substance clarity, concept mapping level at beginning, minds-on hands-on engagements, scaling up skills of understanding, enhancement of practical activity and knowable construction effects.

Accordingly, the effectiveness of performance of delivery process of the purposely selected lesson topic “identification of acidity and basicity of solutions” conducted through the face-to-face peer-teaching exhibited moderate professional career that increasingly developed from 80 to 90% in experience development and constructing knowledge.

However, the average effectiveness scores of performances of the lesson delivery conducted through peer-teaching has accounted for 81% confirming that much development in improvisation of teaching materials and employing for biology lesson delivery, which enhanced trainees in constructing subject matter knowledge and skills of teaching.

Analysis of collected data using observation checklists on the process of lesson delivery of understanding and practicing five referenced experimental lesson topics like osmosis in potato cells, diffusions, identifying stomata position on a leaf, leaf transpiration and test for starch conducted through peer-teaching was assessed.

In view of this, the score of understanding and practicality on referenced experimental biology lesson topic showed the lowest score of 75% in identifying the position of stomata the highest scores of 90% in osmosis and leaf transpiration.

The total average performance effectiveness in understanding and practicality of the five referenced experimental biology lesson topics of trainees scored of 84% which is relatively better than the scores gained through purposive lesson topic score of 81%.

In evaluating the level of creativity and skill of performance of collecting materials, arrangement and construction for supporting the biological experiment-based lesson topics and making doable and understandable for users was the principal objective.

RESULTS

As a result, the performance effectiveness of biology using creative education for improvising experimental teaching materials for the delivery of both purposive and referenced experimental biology lesson topics conducted through peer-teaching of trainees was 82.5% of expected outcomes.

The result included concept mapping and creative construction of subject matter knowledge and skills teaching profession of conveying practicality as pioneer to higher level of lesson delivery process concluded with better teaching effectiveness.

DISCUSSION

In the analysis of creative improvisation of teaching materials to adapt for experimental biology lessons require divergently and convergent thinking for consolidating ideas for the practical application of lesson delivery of biology.

According to Starco (2000), creative education is a strategy that plays great roles in competency building and successful problem solving. Creativity is the major practical foundation for divergent and converging thinking to construct skills and cultivate within prevailing constraints and produce usable teaching materials and solve problems in more explicit form of cultivating and uses of divergent and convergent thinking skills in practice.

Creative education is the one that supports innovation of educational systems through improvisation of teaching materials and implement for the delivery lessons as basic mind sets of skill development to procedurally carryout, situate to teachable conditions, make the learning styles funnier and faster and improve achievements.

Wayne (2006) states that “the most powerful way to develop creativity in your students is to be a role model and children develop experience not when you tell them to, but when you show and engage them into various formats of assignments and activities.

In general, creativity is understood as universal and holistic aspect of human life and the properties of valued ability and depends upon the school environment (school, family, social and classroom) that may be influenced by many different variables (availability of resources, technology, established classroom atmosphere, teachers and students.

Craft (2005) describes that the taxonomy of learning objectives, which educators set for students to be successful at the end of the lesson contains Cognitive, Affective and Psychomotor domains designed to motivate a focus on creativity. He continually stated that creativity facilitates and inspires student-learning and support teachers to use the knowledge of students of subject matter in teaching-learning sciences and technology.

Nonetheless, ideas to promote creativity in biology classrooms make more rooms for visual reflections and integrate to more hands on learning, keep the class flexible, introduce unconventional learning materials, encourage discussion and replace hierarchy of learning with collaborative learning styles.

According to Jong-Rok (2001), creativity is the essence of personality in the sense of the whole person having diverse physical, psychological, emotional and social properties and fundamental human nature.

Creative education satisfies the dissatisfactions of current education and its changing role fosters creativity in education intended to address many concerns and barriers of creative teaching are the lack of mind sets of teachers including the seeing of creativity as an extra work, discouraging system, standards and large class size pressures (Robina, 2010).

In view of the outcome of this research, anticipated results were acquired at high ultimate through which numberless teaching resources were improvised and made to serve as principles of investigational tools of biology teaching and may take shapes depending up on objectives, setups of experiments and scope of interpretation.

CONCLUSION

In both purposive and referenced groups of experimental biology lessons delivery conducted through peer-teaching, trainees used created materials for designated purposes properly and concluded the teaching-learning processes with higher performances of effectiveness successfully.

Herein, improvisation of unconventional learning materials and application into classrooms for experimental biology lesson delivery process besides using textbooks created educational entertainments, creative ideas of learning by doing and produced conceptual as well as practical understanding as a model minds-on and hands-on in envisaging anticipated outcomes in various perspectives.

Hence, creativity and improvisation of educational materials and properly employing in training biology educators imprinted professional quality in biology education systems.

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