A Comparison on the Effectiveness of Educational Taxonomies for Developing Scientific Creativity among Secondary School Students

Dr. Revati N., Asst. Professor, N.S.S. Training College, Changanacherry, Kottayam, Kerala,

Dr. K.P. Meera, Professor & Head of the Department, Dept. of Education, Calicut University, Kerala.

Abstract

Although aims give direction to educational system, and bring all round development of students, all these aims cannot be attained by a teacher. To make a teacher's task easy, aims are narrowed down to objectives which are specific and realisable portions of aims. . Classification of learning objectives in an ordered system is called Taxonomy of Educational Objectives. To develop fundamental understanding about science, children need to think and act creatively. Scientists utilise their creativity in every stage of their work (Lederman,2000) Scientific creativity helps an individual in many areas like, comprehending new ideas and concepts of scientific knowledge, formulation of new theories in science, doing new experiments to prove natural laws, giving originality to scientific plans and projects etc. Instructions based on SOLO Taxonomy, Revised Bloom's Taxonomy and Mc Cormack and Yager's Taxonomy is effective to develop Scientific Creativity among secondary school students. Mc Cormack and Yager's Taxonomy is more effective to develop Scientific Creativity among secondary school students and then comes Revised Bloom's Taxonomy followed by SOLO Taxonomy. The sample of the study consists of 210 secondary school students of Kottayam district and experimental method was used to study the problem.

Key words: SOLO taxonomy, Revised Bloom's Taxonomy, Mc Cormack and Yager's Taxonomy, Scientific Creativity.

Aims of Science Education

To quote Albert Einstein, the goal of education is "to produce independently thinking and acting individuals". The basic goal of science education is to produce individuals capable of understanding and evaluating information and producing sufficient number of skilled and motivated scientists, engineers and other science based professionals. There comes the need of an instruction to adapt the instructional goals and skills of the learner. General aims of science education are development of knowledge, skills, abilities, scientific attitude, reflective thinking, habits, interests, appreciation, providing work for leisure, training for better living and choosing a career (Hima 2013).

Although aims give direction to educational system, and bring all round development of students, all these aims cannot be attained by a teacher. To make a teacher's task easy, aims are narrowed down to objectives which are specific and realisable portions of aims. Thus objectives are a set of achievable ends which are acquired in pursuit of overall aims (Ball & Washburn, 2001). By framing objectives or outcomes of learning, a teacher gets description of abilities and values which he or she intends to instil among the students. It acts as a frame of reference to take various decisions regarding content, method of teaching, learning experiences and evaluation (Krathwohl, 1956). So it becomes a necessity to organize objectives of education in a better way that teachers can get guidance in choosing an objective. Classification of learning objectives in an ordered system is called Taxonomy of Educational Objectives. There are various taxonomies put forwarded by many experts in education, according to their ideals. Some of the important taxonomies in science education are as follows,

Blooms Taxonomy

Bloom's taxonomy is a classification of learning objectives in education developed by a committee of educators chaired by Benjamin S. Bloom in 1956. It is a set of three models used to classify learning objectives on the basis of level of complexity and specificity (Bloom, 1956). These objectives or behavioural outcomes of individuals resulting from instruction are classified into three domains, Cognitive domain, Affective domain and Psychomotor domain.

Bloom's Revised Taxonomy

In 1990's, Lorin Anderson, a former student of Benjamin S. Bloom revised the original Bloom's Taxonomy and named it Revised Bloom's Taxonomy. In the new version of Bloom's Taxonomy, the names of the six categories were changed from noun to verb forms, because thinking is an active process (Anderson, 2001). There was a change in terminology also ie, knowledge changed into remembering, comprehension became understanding and synthesis into creating. Anderson rearranged the six categories with higher objective as creating. The knowledge level of the original taxonomy is divided into four levels; factual, conceptual, procedural, and metacognitive. Objectives of Revised Bloom's taxonomy are remembering, understanding, applying, analysing, evaluating and creating.

Mc Cormack and Yager's Taxonomy

Mc Cormack and Yager in 1989 developed a new "Taxonomy for Science Education" that broadens the view of science education beyond the two domains of content and processes. The basic aim behind the designing of taxonomy was to make the students scientifically and technologically literate. They incorporated five categories or domains of science education. The domains coming under Mc Cormack and Yager's taxonomy are, Knowledge Domain, Exploring and discovering, Imaging and Creating, Using and Applying and Feeling and valuing.

SOLO Taxonomy

This taxonomy was developed by John Biggs and Kevin Collis in 1982. SOLO helps the learner to have total control over their learning; and to decide what steps have to be taken while learning. Structure of Observed

Learning Outcomes or SOLO Taxonomy gives a simple, reliable and strong model for three levels of understanding; surface, deep and conceptual (Biggs & Collis 1982). SOLO provides structured framework and direction to progress their thinking and learning. This taxonomy explains the growing complexity of a learner's activity. SOLO taxonomy has five main stages, Pre-structural, Uni-structural, Multi-Structural, Relational, and Extended Abstract

Need and Significance of the Study

Science is of great importance to 21st century secondary school students, because in an education system it is a gateway of opportunities, which leads to economic and social development (Handelsman, 2004). Science along with its educational purposes develops reasoning, curiosity, creativity, positive attitude and problem solving attitude which are essential for every citizen. Science is needed for the betterment and development of every country. Alignment of course activities and testing strategies with learning outcomes is critical for effective course designing (Wiggins & Mc Tighe, 1998).

Although aims give direction to educational system, and bring all round development of students, aims are narrowed down to objectives which are specific and realisable portions of aims. Objectives vary with aims of education, nature of the society, culture, nature of the discipline, age and ability of the learner, nature of the content, availability of the resources, quality of the teaching, teaching methods etc. (Miry, 1995). Existing education structure has not been able to imbibe a proper scientific culture than narrowing down to the field of examinations, marks and degrees. Science education must make scientists who work and unlock the laws of nature with their own efforts.

To develop fundamental understanding about science, children need to think and act creatively. Scientists utilise their creativity in every stage of their work (Lederman, 2000). That is why science is said to be a process containing creativity components in its each step (Saxena, 1994). Creativity can be defined as finding gaps in the problem or information, creating hypotheses and transmitting the data (Torrence, 1995, Dass 2004). While examining this definition it becomes clear that creativity and scientific method are having similar step. So it can be concluded that science and creativity are two sides of a coin. Scientific creativity helps an individual in many areas like, comprehending new ideas and concepts of scientific knowledge, formulation of new theories in science, doing new experiments to prove natural laws, giving originality to scientific plans and projects etc. The individuals who use creativity can make their science education functional, and therefore the scientific information can be the basis for producing a valuable product instead of just giving amazing information (Aktamis & Ergin, 2008).Therefore one of the important aims of science education must be to inculcate creative thinking skills in children from elementary school onwards.

Scientists and science educators believe in approaches and attitudes, which are parallel with the procedures and attitudes of scientists. With the help of Taxonomy of Educational Objectives, a teacher can define and translate the objectives accordingly. This improves the quality of educational outcomes, curriculum, and transaction and evaluation procedures.

Objectives of the study

To find out the effectiveness of instructions based on SOLO taxonomy, Revised Bloom's Taxonomy and Mc Cormack and Yager's Taxonomy on Scientific Creativity of secondary school students.

Hypotheses

1. There will be no significant difference between the mean pre-test scores of Experimental group I (Group receiving instruction based on SOLO Taxonomy), Experimental group II (Group receiving instruction based on Revised Bloom's Taxonomy) and Experimental group III (Group receiving instruction based on Mc Cormack and Yager's Taxonomy) for Scientific Creativity of secondary school students.
2. There will be no significant difference between the mean post test scores of Experimental group I, Experimental group II, and Experimental group III for Scientific Creativity of secondary school students.
3. There will be no significant difference between the mean pre-test and post test scores of Scientific Creativity of Experimental group I, Experimental group II and Experimental group III
4. There will be no significant difference between the mean gain scores of Scientific Creativity of Experimental group I, Experimental Group II and Experimental group III.

Methodology

For finding out the effectiveness of an instruction based on SOLO Taxonomy, Revised Bloom's Taxonomy and Mc Cormack and Yager's Taxonomy on Scientific Creativity, experimental method was adopted.

Experimental Design

Quasi-experimental design (pre-test post-test non-equivalent group design) was employed.

Sample used for the study

The present study was conducted on a sample of 210 students of standard VIII drawn from three schools of Changanachery. The schools selected for the study were NSS Boys High school, Perunna, NSS Girls High School Perunna and NSS High School Kidangoor. Among the 210 students of Experiment group, three groups of 70 students were taken for three different taxonomies

Tools used for the study

The following tools were developed and used in the experimentation.

1. Raven's standard progressive matrices
2. Scientific Creativity Test (Weiping Hu and PhilipAdey,2002)

3. Lesson transcripts based on SOLO Taxonomy (Meera and Revati,2016)
4. Lesson transcripts based on Revised Bloom's Taxonomy (Meera and Revati,2016)
5. Lesson transcripts based on Mc Cormack and Yager's Taxonomy (Meera and Revati,2016)

Statistical Techniques employed

- Descriptive statistics like Mean, Median, Mode, and Standard deviation
- Test of significance of difference between the means scores of three dependent groups
- Analysis of Variance (ANOVA) followed by Scheffe's Test of Multiple Comparison.
- Analysis of Co Variance (ANCOVA)

Comparison of Scientific Creativity of Secondary School Students in the Experimental Group I (SOLO Taxonomy), Experimental Group II (Revised Bloom's Taxonomy) and Experimental Group III (Mc Cormack and Yager's Taxonomy)

After equating the group, the investigator administered pre test in Scientific Creativity, among the three experimental groups. Then administered intervention strategy in each experimental group like Experimental Group I (SOLO Taxonomy), Experimental Group II (Revised Bloom's Taxonomy) and Experimental Group III (Mc Cormack and Yager's Taxonomy).After the intervention investigator administered same test as post test in all the three the groups. Then tabulated the scores in the pre test and post test and condensed it in to the descriptive statistics of pre test and post test for analysing the preliminary features of the data. Following tables shows the descriptive statistics of the pre test and post test scores of the each group with regard to the learning outcome Scientific Creativity.

Descriptive statistics of pre test scores of Scientific Creativity among Secondary school students in the Experimental Group I (SOLO Taxonomy) Experimental Group II (Revised Bloom's Taxonomy) and Experimental Group III (Mc Cormack and Yager's Taxonomy)

a) Before the experiment

Before starting the experiment, Scientific Creativity test was administered by the investigator as pre test to all the groups. Each group consisting a total number of 70 students. The pre test scores obtained by the students in three groups were condensed into arithmetic mean, median, mode, standard deviation. This was to get a general picture of the performance of students in the three groups before the experiment.

Table 1 *Descriptive statistics of Scientific Creativity among secondary school students before the experiment*

Statistics	SOLO Taxonomy	Revised Bloom's Taxonomy	Mc Cormack and Yager's Taxonomy
Mean	18.56	19.17	20.89
Median	18.00	20.00	21.00
Mode	18	20	28
Std. Deviation	6.264	6.769	7.412
Skewness	-.051	-.125	-.174
Kurtosis	-.647	-.575	-.856

Obtained mean score for Scientific Creativity of Revised Bloom's Taxonomy group is 19.17, SOLO taxonomy group is 18.56, and that of Mc Cormack and Yager's Taxonomy group is 20.89. All these values indicated that, the average Scientific Creativity of the students in each group is more or less the same.

The median scores are 18, 20 and 21 for SOLO Taxonomy, Revised Bloom's Taxonomy, and Mc Cormack and Yager's Taxonomy group students respectively, which indicated the middle score of the Scientific Creativity in the group. The median value represent that 50% of the students are above and below the value. .

The mode value obtained for Revised Bloom's Taxonomy, SOLO Taxonomy and Mc Cormack and Yager's Taxonomy group are 18, 20, and 28 respectively. These are the most repeating scores in the Scientific Creativity test. The standard deviation of the SOLO Taxonomy group is 6.26, Revised Bloom's Taxonomy group is 6.76 and Mc Cormack and Yager's Taxonomy group is 7.41. These values show the variations of scores in each group before the intervention.

b) After the Experiment

The same Scientific Creativity Test was administered by the investigator as post test to all the groups. Each group consisting a total number of 70 students. The post test scores obtained by the students in three groups were condensed into Arithmetic Mean, Median, Mode, and Standard Deviation. This was done to get a general picture of the distribution.

Table 2 *Descriptive statistics of Scientific Creativity among secondary school students after the experiment*

Statistics	SOLO Taxonomy	Revised Bloom's Taxonomy	Mc Cormack and Yager's Taxonomy
Mean	27.71	28.61	35.37
Median	27.50	28.50	36.50
Mode	35	32	40
Std. Deviation	4.505	4.897	4.926
Skewness	.353	-.604	-.942
Kurtosis	-.931	-.327	-.267

The obtained mean score of Scientific Creativity for SOLO Taxonomy group is 27.71, Bloom's Taxonomy group is 28.61 and Mc Cormack and Yager's Taxonomy group is 35.37. All these values indicated that the students from each group have different levels of Scientific Creativity after the experiment.

The Median scores are 27.50, 28.50 and 36.50 for SOLO Taxonomy, Revised Bloom's Taxonomy and Mc Cormack and Yager's Taxonomy group students respectively, which indicated the middle score of the Scientific Creativity in the each group. The median value represents that 50% of the students lies above and below the value.

The mode value obtained for the SOLO Taxonomy, Revised Bloom's Taxonomy and Mc Cormack and Yager's Taxonomy group are 35, 32 and 40 respectively. Mode value signifies most repeating scores in the Scientific Creativity test. The Standard Deviation of the SOLO Taxonomy Group is 4.50, Revised Bloom's Taxonomy group is 4.89, and Mc Cormack and Yager's Taxonomy group is 4.92. These values show that there is variation of scores in each group after the intervention.

Effectiveness of Instructions Based on, SOLO Taxonomy, Revised Bloom's Taxonomy, and Mc Cormack and Yager's Taxonomy on Scientific Creativity of Secondary School Students

The purpose of this study is to compare the effectiveness of instruction based on the SOLO, Revised Bloom's and Mc Cormack and Yager's Taxonomy on Scientific Creativity of secondary school students. For this the investigator developed following hypothesis, and tested these hypotheses using 't' test , 'F' test, such as ANOVA and ANCOVA followed by adjusted post-test.

Analysis and Interpretation of data

Comparison of pre test scores of Scientific Creativity among Experimental group I (Group receiving instruction based on SOLO Taxonomy), Experimental group II (Group receiving instruction based on Revised Bloom's Taxonomy) and Experimental group III (Group receiving instruction based on Mc Cormack and Yager's Taxonomy)

For this, the investigator compared all the pre test scores of each experimental group using One Way Analysis of Variance. The data and results of the test of significance were given in the table below.

Table 3 *Data and result of pre test scores of Scientific Creativity in each Experimental Group*

Source of variance	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	203.895	2	101.948	2.18	p>0.05
Within Groups	9660.300	207	46.668		
Total	9864.195	209			

The obtained 'F' value is 2.18 which is not significant even at 0.05 level of significance (p>0.05). This shows that there is no significant differences in the pre test mean scores of students in each experimental group. Therefore all the three experimental groups do not differ significantly in their Scientific Creativity. So it is inferred that, before the intervention three groups were more or less same in Scientific Creativity.

Comparison of post test scores in Scientific Creativity among Experimental group I, Experimental group II and Experimental group III

For this, the investigator compared all the post test scores in the each experimental groups using One Way Analysis of Variance. The data and results of the test of significance were given in the table below.

Table 4 *Data and result of post test scores of Scientific Creativity in the each experimental group*

Source of variance	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2452.352	2	1226.176	53.67	P<0.01
Within Groups	4729.214	207	22.846		
Total	7181.567	209			

All three experiment groups differ significantly in their scientific Creativity after the intervention. So it is inferred that after the intervention three groups differ significantly in their Scientific Creativity. In order to find out the initial difference among the three groups investigator used Scheffe post hoc test.

Table 5 *Data and results of the Scheffe post hoc test for the difference in scientific creativity*

Group	N	Subset for alpha = 0.05	
		1	2
SOLO Taxonomy	70	27.71	
Revised Bloom's Taxonomy	70	28.61	
Mc Cormack and Yager's Taxonomy	70		35.37

Above table shows that the obtained mean scores of Mc Cormack and Yager's Taxonomy is 35.37, SOLO taxonomy 27.71 and Revised Bloom's Taxonomy is 28.61. So it is clear that Mc Cormack and Yager's Taxonomy significantly differ from SOLO and Revised Bloom's for Scientific Creativity.

Comparison between the mean Pre test and Post test scores of Scientific Creativity of Experimental Group I

The difference between the pre test and post test mean scores of the Experimental group I (SOLO Taxonomy) were tested for significance by finding the Critical Ratio using Paired Sample 't' test. The data and results of the test of significance were given in the table below.

Table 6 *Data and result of Pre test and Post test scores of Scientific Creativity in Experimental Group I*

Tests	Mean	N	Std. Deviation	r	t	Sig
Pre test	18.56	70	6.264	.30	11.87	P<0.01
Post test	27.71	70	4.505			

Since the mean of post test 27.71 is greater than that of pre test mean 18.56, it is inferred that instruction based on the SOLO Taxonomy is effective in developing Scientific Creativity.

Comparison between the mean Pre test and Post test scores in Scientific Creativity of Experimental Group II.

The difference between the pre test and post test mean scores of the Experimental group II (Revised Bloom's Taxonomy) were tested for significance by finding the Critical Ratio using paired sample 't' test. The data and results of the test of significance were given in the table below.

Table 7 *Data and result of Pre test and Post test scores of Scientific Creativity in Experimental Group lI*

Tests	Mean	N	Std. Deviation	r	t	Sig
Pre test	19.17	70	6.769	.413	12.12	P<0.01
Post test	28.61	70	4.897			

Since the mean of post test 28.61 is greater than that of the pre test mean 19.17, it is inferred that instruction based on the Revised Bloom's Taxonomy is effective in developing Scientific Creativity.

Comparison between the mean Pre test and Post test scores of Scientific Creativity of Experimental group III.

The difference between the pre test and post test mean scores of the Experimental group III (Mc Cormack and Yager's Taxonomy) were tested for significance by finding the critical ratio, using paired sample 't' test. The data and results of the test of significance were given in the table below.

Table 8 *Data and result of Pre test and Post test scores of Scientific Creativity in the Experimental Group III*

Tests	Mean	N	Std. Deviation	r	t	Sig
Pre test	20.89	70	7.412	.089	13.04	P<0.01
Post test	35.37	70	4.926			

The obtained't' value is 13.04, which is highly significant at 0.01 level of significance, that means there exists a significant difference between pre test and post test mean scores among the Mc Cormack and Yager's Taxonomy group. Since the mean of post test 35.37 is greater than that of the pre test mean 20.89, it is inferred that instruction based on Mc Cormack and Yager's Taxonomy is effective in developing Scientific Creativity.

Comparison between the Mean Gain Scores of Scientific Creativity between Experimental Group I and Experimental Group II

The difference between the Mean Gain Scores of the Experimental group I(SOLO Taxonomy) and Experimental Group II (Revised Bloom's Taxonomy) were tested for significance by finding the critical ratio, using Independent Sample't' test. The data and results of the test of significance are given in the table below.

Table 9 *Data and result of Pre test and Post test Gain scores of Scientific Creativity of Experimental group I (SOLO) and Experimental Group II (Revised Bloom's)*

Tests	Mean	N	Std. Deviation	t	Sig
Revised Bloom's Taxonomy Based Instruction	9.44	70	6.51	0.259	P>0.05
SOLO Taxonomy based Instruction	9.15	70	6.4		

The obtained't' value is .259, which is not significant at 0.05 level of significance. It means that, there exists no significant difference between Mean Gain Scores of Revised Bloom's Taxonomy Group and SOLO Taxonomy Group in their Scientific Creativity.

Comparison between the Mean Gain Scores of Scientific Creativity among Experimental group II and Experimental Group III

The difference between the mean gain scores of the Experimental group II (Revised Bloom's Taxonomy) and Experimental Group III (Mc Cormack and Yager's Taxonomy) were tested for significance by finding the Critical Ratio, using Independent sample't' test. The data and results of the test of significance were given in the table below.

Table 10 *Data and result of Pre test and Post test Gain scores of Scientific Creativity among Experimental group II and Experimental Group III*

Tests	Mean	N	Std. Deviation	t	Sig
Revised Bloom's	9.15	70	6.4	3.94	P<0.01
Mc Cormack and Yager's	14.4	70	9.25		

Since the mean gain of Mc Cormack and Yager's Taxonomy group, 14.4 is greater than that of the mean gain of Revised Bloom's 9.15, it is inferred that students from Mc Cormack and Yager's Taxonomy group have high gain in their Scientific Creativity score.

Comparison between the Mean Gain Scores of Scientific Creativity among Experimental group II and Experimental Group III

The difference between the Mean Gain Scores of the Experimental group I (SOLO Taxonomy) and Experimental Group III (Mc Cormack and Yager's Taxonomy) were tested for significance by finding the Critical Ratio, using independent sample 't' test. The data and results of the test of significance were given in the table below.

Table 11 *Data and result of Pre test and Post test Gain scores of Scientific Creativity among Experimental group I and Experimental Group III*

Tests	Mean	N	Std. Deviation	t	Sig
SOLO Taxonomy Group	9.44	70	9.25	3.72	P<0.01
Mc Cormack and Yager's Taxonomy Group	14.4	70	6.51		

Since the mean gain of Mc Cormack and Yager's Taxonomy group 14.4, is greater than that of the mean gain of SOLO 9.4, it is inferred that students from Mc Cormack and Yager's Taxonomy group have high gain in their Scientific Creativity score.

Comparison of Effectiveness of Instructions based on Revised Bloom's Taxonomy, SOLO Taxonomy, and Mc Cormack and Yager's Taxonomy on Scientific Creativity of secondary school students

In this section investigator compared the post test score for Scientific Creativity of the secondary school students in the three groups using Univariate Analysis. Here the investigator took pre test as co-variate. Following tables show the results.

Table 12 *Data and Results of the Univariate analysis, for testing the Effectiveness of Instructions based on Revised Bloom's Taxonomy, SOLO Taxonomy, and Mc Cormack and Yager's Taxonomy on Scientific Creativity of secondary school students*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Pre test Scientific Creativity	180.844	1	180.844	8.191	P<0.01
Group	2219.142	2	1109.571		P<0.01

				50.254
Error	4548.371	206	22.079	
Total	203389.000	210		

Above table shows the obtained ‘F’ for the error is 50.25 which is highly significant at 0.01 level of significance ($p<0.01$). It means that, instructions based on Revised Bloom’s Taxonomy, SOLO Taxonomy, and Mc Cormack and Yager’s Taxonomy were effective for developing Scientific Creativity among secondary school students.

The difference between the adjusted y means was tested for significance. The data for adjusted means of post test scores of students in experimental groups were given in the following table.

Table 13 *Data for adjusted means of post test scores for Scientific Creativity among secondary school students who received instructions based on Revised Bloom’s Taxonomy, SOLO Taxonomy, and Mc Cormack and Yager’s Taxonomy*

Groups	N	Mx	My	M_{XY}		t
SOLO Taxonomy(A)	70	18.56	27.71	27.84	A-B	1.02
Bloom’s Taxonomy(B)	70	19.17	28.61	28.66	B-C	9.13*
Mc Cormack and Yager’s(C)	70	20.89	35.37	35.18	A-C	8.17*
Total	210	19.54	30.5			

The adjusted mean score of Mc Cormack and Yager’s is 35.18, which is greater than the adjusted mean score of SOLO Taxonomy 27.84, and Revised Bloom’s Taxonomy 28.66. In order to find out the significant mean differences among the each taxonomy investigator used pair wise comparison. Following table shows the pair wise comparison.

Table 14 *Data and result of the significant mean differences among Revised Bloom's Taxonomy, SOLO Taxonomy, and Mc Cormack and Yager's Taxonomy using Pair wise Comparisons*

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.
SOLO taxonomy	Revised Bloom's Taxonomy	.816	.795	P>0.05
	Mc Cormack and Yager's Taxonomy	-7.339*	.802	P<0.01
Revised Bloom's Taxonomy	SOLO taxonomy	-.816	.795	P>0.05
	Mc Cormack and Yager's Taxonomy	-6.523*	.798	P<0.01
Mc Cormack and Yager's Taxonomy	SOLO taxonomy	7.339*	.802	P<0.01
	Revised Bloom's Taxonomy	6.523*	.798	P<0.01

Among the mean differences Mc Cormack and Yager's Taxonomy have high difference compared to SOLO and Revised Bloom's. So it can be concluded that Mc Cormack and Yager's Taxonomy (35.18) is more effective to develop Scientific Creativity among secondary school students and then comes Revised Bloom's Taxonomy (28.66) for developing Scientific Creativity. From the present study, it was found that SOLO Taxonomy comes below the other two taxonomies in developing Scientific Creativity among secondary school students.

Findings of the study

Instructions based on SOLO taxonomy, Revised Bloom's Taxonomy and Mc Cormack and Yager's Taxonomy is effective to develop Scientific Creativity among secondary school students. This conclusion was arrived based on the following statistical inference.

While comparing the pre test and post test mean score, the obtained‘t’ value is 11.87 in the experimental Group I ,the obtained ‘t’ value is 12.12, in experimental Group II, and the obtained ‘t’ value is 13.04, for experimental Group III. All the‘t’ values are significant at 0.01 level of significance. The mean gain score scores of Scientific Creativity of Experimental group I (SOLO) and Experimental Group II (Revised Bloom’s), the ‘t’ value is .259, which is not significant ($p>0.05$) and gain scores of Scientific Creativity of Experimental group II and Experimental Group III, the obtained ‘t’ value is 3.94 and gain scores of Scientific Creativity of Experimental group I and Experimental Group III, the ‘t’ value is 3.72. Both‘t’ values were significant. And obtained ‘F’ for the Error is 50.25 which is highly significant at 0.01 level of significance ($p<0.01$). Moreover the obtained mean difference is significant between Revised Bloom’s Taxonomy with SOLO Taxonomy (.816) and Revised Bloom’s Taxonomy with Mc Cormack and Yager’s Taxonomy is 6.52. Both differences are highly significant. In the case of SOLO with Mc Cormack and Yager’s Taxonomy also, the mean difference (7.33) is highly significant. Among the mean differences Mc Cormack and Yager’s Taxonomy have high difference compared to SOLO and Revised Bloom’s Taxonomy. So it can be concluded that Mc Cormack and Yager’s Taxonomy is more effective to develop Scientific Creativity among secondary school students and then comes Revised Bloom’s Taxonomy. From the present study, it was found that SOLO Taxonomy comes below the other two taxonomies in developing Scientific Creativity among secondary school students.

From this statistical observation, it can be concluded that Mc Cormack and Yager’s Taxonomy is more effective to develop Scientific Creativity among secondary school students followed by Revised Bloom’s Taxonomy and SOLO Taxonomy.

Conclusions

Among the mean differences Mc Cormack and Yager’s Taxonomy have high difference compared to SOLO and Bloom’s. So it can be concluded that Mc Cormack and Yager’s Taxonomy is effective to develop Scientific Creativity among secondary school students and then comes Revised Bloom’s Taxonomy for developing Scientific Creativity. From the present study, it was found that SOLO Taxonomy comes below the other two taxonomies in developing Scientific Creativity among secondary school students.

An objective is a goal or endpoint of something towards which actions are directed. Objectives generally indicate the end points of a journey. They specify where you want to be or what you intended to achieve at the end of a process. An educational objective is that which a specific educational instruction is expected to make or accomplish. Instructional objectives are very important component of teaching system, as they provide necessary feedback for the adjustment of curriculum, teaching method, teaching aids and assessment. They also show how much appropriate the curriculum is. Learning taxonomies are valuable tool for classifying learning objectives. Educational taxonomy is a helpful and frequently used resource to write student learning outcomes.

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