

EVALUATING THE NATIONAL CURRICULUM OF COMPUTER SCIENCE GRADE 6 TO 8 BY USING BLOOM'S TAXONOMY

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Abstract

Critical thinking, problem solving and logical reasoning are considered as the 21st century learning skills. These higher order thinking skills (HOTS) can only be developed through curriculum and teaching and learning strategies, because it includes critical, logical, reflective, metacognitive, and creative thinking.

The purpose of this study is to analyze National Curriculum 2006 (Pakistan) of Computer Education in order to observe that how much it is helpful for the development of higher order thinking skills among the students and whether it has focused on merging 21st century interdisciplinary themes with core contents of the subject.

The National Curriculum 2006 (Pakistan) of Computer Education from grade VI to VIII was analyzed using the revised blooms taxonomy. Out of six levels, upper three levels Analyzing, Evaluating and Creating were considered as HOTS. Frequency and Proportions were calculated for Student Learning Outcomes (SLOs) meeting HOTS criteria. P21 framework was used for checking the contents and SLOs which merging the 21st century interdisciplinary themes in curriculum.

Overall only 9% of the SLOs in curriculum met the requirement of HOTS. There was a slightly increasing trend was observed from grade 6 to 8. Grade 6 had 6%, grade 7 had 9% and grade 8 had 11% of HOTS.

However overall proportion of SLOs meeting HOTS was low but an increasing trend was observed from grade VI to grade VIII. In order to develop HOTS among the students, there is a need to redesign the curriculum, teachers should be trained accordingly and assessment standards should also be meeting with curriculum needs.

It will help in the re-designing of National Curriculum for Computer Education Grade VI-VIII. This study can be expended to analyze the National Curriculum for other subjects.

Keywords: Higher Order Thinking Skills, Curriculum, SLOs, Critical Thinking, 21st century skills.

1. INTRODUCTION

Over the past decades, education in the country has been based on teaching students the "3 R's" which are reading, writing and arithmetic. In this out-dated approach, a teacher taught the content by repetition, making students say or write the same thing over and over. Nowadays education scenario has been changed in the world particularly in the developed countries. Modern education is based on teaching students 4C's which are critical thinking, communication, Collaboration and creativity. These 4C's are the 21st century learning skills. Today the paradigm of education has been transformed in all over the world; therefore, in order to prepare the students for tomorrow it is necessary to develop their 21st century skills. Because Knowledge, as an outcome of education, is no longer believed to be enough to create the kind of citizens needed to effectively cope with the social, economic and technological changes in the world (Assaly & Smadi, 2015). Equipping the students with 21st century skills we need to develop their higher order thinking skills (HOTS) as they can survive in this new era of education. Teaching practices are not enough to promote the HOTS; no doubt there is a close relationship between curriculum and teaching. The curriculum is a fundamental

design which work as a roadmap for learning whereas teaching is a way by which that type of learning can be reached at the students. Teaching Higher Order Thinking Skills (HOTS) has its own challenges and need to be emphasized in the curriculum as it is one of the skills of the 21st century (Nazri Hassan et al, 2017).

1.1 Framework for 21st Century Learning Skills: P21 Framework

The Partnership for 21st Century (P21) Skills was formed in 2002 through the efforts of the government: U.S. Department of Education, founding organizations includes AOL Time Warner Foundation, Apple Computer, Inc., Cable in the Classroom, Cisco Systems, Inc., Dell Computer Corporation, Microsoft Corporation, National Education Association, SAP and individuals: Ken Kay, President and Co-Founder and Diny Golder-Dardis, Special Advisor and Co-Founder. It was developed with the input from teachers, education experts, policy makers and business leaders to define and illustrate the skills and knowledge students need to succeed in work, life and citizenship (Partnership for 21st century learning, 2002).

P21 Learning Framework is a model for incorporating 21st century skills into learning; it has widely become the recognized model for infusing 21st Century Skills into the curriculum. (Partnership for 21st century learning, 2002). It is unified vision for learning to ensure student success in a world where change is constant and learning never stops. There are hundreds of educational agencies and organizations who have adopted the P21 Framework, either formally or informally, to guide their learning communities and are embedding 21st century skills in curriculum and professional development (Partnership for 21st Century learning, 2002).

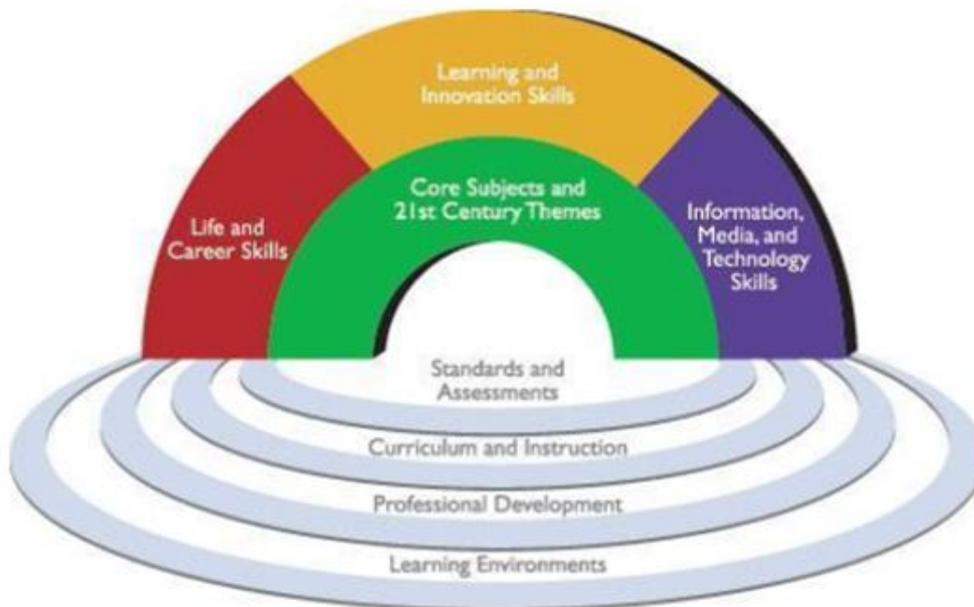


Figure 1. P21 Framework for 21st Century Learning

The elements of P21 Framework for 21st century are core subjects & 21st century themes, life & career skills, Learning & innovation skills, Information, media and technology skills described in the rainbow are student outcomes. The framework suggests that along with the mastery of core subjects, schools should promote the understanding of academic contents by merging 21st century interdisciplinary themes into key subjects (Partnership for 21st century learning, 2002).

Table 1.1 Core Subjects and 21st Interdisciplinary Themes of P21 framework

Core Subjects	21 st Century Interdisciplinary Themes
English, reading or language arts	Global Awareness
World Languages	Financial, Economic, Business and Entrepreneurial Literacy
Arts	Civic Literacy
Mathematics	Health Literacy
Economics	Environmental Literacy
Science	
Geography	

This framework uses core academic subjects as a vehicle for teaching life and career skills, learning and innovation skills, and information and media skills. These skills allow students to be better-prepared for today's highly collaborative, innovation-focused workforce. For this reason, student outcomes in this framework are often described in terms of the future impact they will have for students when they seek employment (Sproutfundorg, 2016).

Table 1.2 Life & Career Skills, Learning & Innovation Skills, and Information & Media Skills

Life and Career Skills	Learning & Innovation Skills	Digital Literacy Skills
Flexibility & Adoptability	Critical Thinking & Problem Solving	Media Literacy
Initiative & Self Direction	Creativity & Innovation	Information Literacy
Social & Cross Cultural	Communication	Information Communication Technology (ICT) Literacy
Productivity & Accountability	Collaboration	
Leadership & Responsibility		
Civic Literacy & Citizenship		
Global Awareness		

Below the rainbow of student's outcomes in P21 framework, elements 21st century standards, assessments, curriculum, instruction, professional development and learning environments are critical systems necessary to ensure student mastery of 21st century skills. These critical systems must be aligned to produce a support system that produces 21st century outcomes for today's students.

1.2 Need of HOTS in Curriculum

Critical thinking, problem solving, logical reasoning, creative thinking and metacognitive are considered as HOTS. It is very hard to imagine that a curriculum without HOTS or with a negligible ratio of HOTS can prepare our students for the challenges of the millennium. As it is very hard to build a building without an architectural blueprint, in the same way it is hard for a teacher to be effective without strong curricula-instructional frameworks. Curricula/instructional frameworks lay out the goals, methods, strategies, approaches, assessments, and resources needed for successful teaching and learning. The better the framework, the more likely will be the sturdiness of the foundation and the effectiveness of instruction (Elliott Seif, 2013). An inclusion of HOTS in curriculum is a better solution for equipping the students with the needs of today's global job market.

The HOTS can only be developed through curriculum and instructional strategies. The education sector of the country needs to take timely strategic efforts for the inclusion of HOTS in curriculum because today's student is tomorrow's educator, doctor, engineer, policy maker, employer and a reformer.

1.3 Bloom's Taxonomy

In 1956, Benjamin Bloom with collaborators Max Englehart, Edward Furst, Walter Hill, and David Krathwohl published a framework for categorizing educational goals at the University of Chicago, known as Bloom's Taxonomy or Taxonomy of Educational Objectives (Vanderbilteu, 2017).

Bloom's taxonomy of educational objectives is a framework for classifying educational objectives, which are the statements of what educators expect their students to have learned by the end of instruction (Krathwohl, 2002). It is an organized method used to define and distinguish different levels of human cognition i.e., thinking, learning, and understanding. Bloom's taxonomy typically used by educators for the development of assessment activities, curriculum, lesson plans, and other learning activities (Liberty concepts, 2013).

In the year 2001, Lorin Anderson a former student of Bloom, David Krathwohl and a group of cognitive psychologists, curriculum theorists, instructional researchers, testing and assessment specialists published revised (Vanderbilteu, 2017). They made some changes in original taxonomy like changing Retrieve previous learned information by recalling facts, terms, basic concepts, and answers names of six levels from noun to verb forms and rearranging them as show in figure no 2.

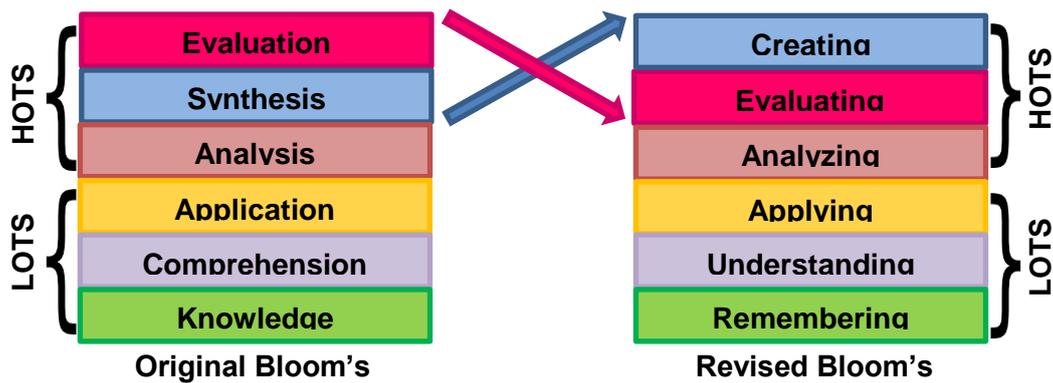


Figure 2. Bloom's Taxonomy

The upper three layers analysis, synthesis and evaluation in original taxonomy and analysing, evaluating and creating in revised Bloom's Taxonomy represents the HOTS. Lower three layers knowledge, comprehension and application in original and remembering, understanding and applying in revised taxonomy represent the lower order thinking skills (LOTS). Description of six cognitive levels of revised Bloom's Taxonomy and sample SLOs are shown in table no. 1.3.

Table 1.3 Description of Revised Bloom's Taxonomy Cognitive Level and Sample SLOs

Level	Description	Sample SLOs
Remembering	Retrieving, recognizing, and recalling previous learned information.	Students will be able to: <ul style="list-style-type: none"> Define the term software List out different hardware devices Label the block diagram of basic computer operations
Understanding	Construct meaning from instructional material, including oral, written, and graphic communication.	<ul style="list-style-type: none"> Classify different hardware devices. Demonstrate the four basic operations of computer. Rephrase the definition of computer.
Applying	Carrying out or using a procedure through executing, or implementing in a given situation.	<ul style="list-style-type: none"> Use media player for playing any audio or video. Apply different font styles on text. Build their basic typing skills.
Analyzing	Break down knowledge into its components and determine the relationships of the components to one another and then how they relate to an overall structure or task.	<ul style="list-style-type: none"> Distinguish system software and application software Compare different application softwares Examine the functionality of various components of a computer system
Evaluating	Make judgments based on criteria and standards, using previously learned knowledge.	<ul style="list-style-type: none"> Assess the performance of different devices Choose best software as per requirement of their system Explain the importance of computer in this century
Creating	Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new sense or structure through generating, planning, or producing.	<ul style="list-style-type: none"> Develop school timetable in MS Word. Design scenery in MS Paint. Delete unwanted files and programs from computer.

Table 1.4 Revised Bloom’s Taxonomy Action Verbs

Higher Order Thinking Skills (HOTS)			Lower Order Thinking Skills (LOTS)		
Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
<ul style="list-style-type: none"> • Choose • Define • Find • How • Label • List • Match • Name • Omit • Recall • Relate • Select • Show • Spell • Tell 	<ul style="list-style-type: none"> • Classify • Compare • Contrast • Demonstrate • Explain • Extend • Illustrate • Infer • Interpret • Outline • Relate • Rephrase • Show • Summarize • Translate 	<ul style="list-style-type: none"> • Apply • Build • Choose • Construct • Develop • Experiment with • Identify • Interview • Make use of • Model • Organize • Plan • Select • Solve • Use • Utilize 	<ul style="list-style-type: none"> • Analyze • Assume • Categorize • Classify • Compare • Conclusion • Contrast • Discover • Dissect • Distinguish • Divide • Examine • Function • Inference • Inspect • List • Motive • Relationships • Simplify • Survey • Take part in • Test for • Theme 	<ul style="list-style-type: none"> • Agree • Appraise • Assess • Award • Choose • Compare • Conclude • Criteria • Criticize • Decide • Deduct • Defend • Determine • Disprove • Estimate • Evaluate • Explain • Importance • Influence • Interpret • Judge • Justify • Mark • Measure • Opinion • Perceive • Prioritize • Prove • Rate • Recommend • Rule on • Select • Support • Value 	<ul style="list-style-type: none"> • Adapt • Build • Change • Choose • Combine • Compile • Compose • Construct • Create • Delete • Design • Develop • Discuss • Elaborate • Estimate • Formulate • Happen • Imagine • Improve • Invent • Makeup • Maximize • Minimize • Modify • Original • Originate • Plan • Predict • Propose • Solution • Solve • Suppose • Test • Theory

1.4 Problem Statement of the Study

The textbook authors, textbook boards, and publishers are working on writing new textbooks which are aligned with the revised National curriculum of 2006. However, the new textbooks of almost all subjects were developed on National Curriculum 2006 upto grade 8 in Sindh province.

But still there is a problem which needs the attention of policy makers, education reformers and curriculum developers is that to investigate the National Curriculum 2006 in order to find out that at what extent it is helpful in the development of higher order thinking skills among the students and equip them with the 21st century learning skills.

1.5 Rationale of the Study

For the best of knowledge such type of study for evaluating the curriculum in order to identify that how much computer education curriculum contributes in development of higher order thinking skills of students and merging 21st century interdisciplinary themes mentioned in table no. 1.1 is the first study in country. This gap becomes the motivation to conduct this study. We live in the era of education where content knowledge of subjects is not enough to survive and secure the future of students.

1.6 Objectives of the Study

1. To identify the number of Lower Order Thinking Skills (LOTS) SLOs in National Curriculum 2007 of Computer Education for grade VI-VIII.
2. To identify the number of (HOTS) SLOs in National Curriculum 2007 of Computer Education for grade VI-VIII.
3. To identify whether curriculum merged the interdisciplinary themes of 21st century learning.

1.7 Definition of Relevant Terms

- **Lower Order Thinking Skills (LOTS):** Lower order thinking skills (LOTS) include remembering information and being able to understand and explain new ideas or concepts. The LOTS are developed very well in our schools through various activities like reading and writing. These skills only enabled the students to recall the information or slightly build their understanding (Britishcouncilorg, 2017).
- **Higher Order Thinking Skills (HOTS):** The upper three layers in Bloom's taxonomy which are analyzing, evaluating and creating represents higher order thinking skills, they are beyond the basic observation of facts and memorization. They require different teaching strategies than the lower order thinking skills (Britishcouncilorg, 2017).
- **Student Learning Outcomes (SLOs):** Student learning outcomes (SLOs) are knowledge, skills and abilities that students have achieved as a result of their involvement in any educational experience (Imtliuse, 2017).

2. METHODOLOGY

2.1 Instrument Used in Study

For the purpose of this study the list of revised Bloom's Taxonomy action verbs shown in table no. 1.4 and description of each cognitive level and sample SLOs shown in table no. 1.3 were used as a checklist to record and tally the cognitive levels of SLOs available in National Curriculum document for Computer Education of grade VI-VIII.

The list of action verbs is composed of table consists of six columns. Each of the six columns represents a cognitive level of Bloom's Taxonomy placed in sequence from lower to higher order thinking skills. The list of action verbs, description of each cognitive level and sample SLOs makes it easier for the researcher to decide the cognitive level of each SLO in curriculum document.

To identify whether curriculum merged the interdisciplinary themes of 21st century learning, the table no. 1.1 Core Subjects and 21st century Interdisciplinary Themes of P21 framework was used.

2.2 Data Collection

The researcher used the national curriculum document for the data collection. In the first step 179 SLOs were found in the whole document. The SLOs were then categorized according to description of each cognitive level of revised Bloom's Taxonomy; sample SLOs available in table no. 1.3 and list of action verbs in table no. 1.4.

2.3 Data Analysis

To analyze the cognitive level of SLOs in curriculum the frequency and percentage for each cognition level were calculated for grade VI, VII and VII. Then total for each cognitive level in the three grades were summed in order to derive a total for each level.

To analyze that curriculum have focused on merging the 21st century interdisciplinary themes with the core contents of the subject , the contents and SLOs of the curriculum were matched with the interdisciplinary themes of 21st century learning like Financial, Economic, Business and Entrepreneurial Literacy, civic literacy, health literacy and environmental literacy of P21 framework available in table no. 1.1.

3. RESULTS AND INTERPRETATION

Table 1.5 Analysis of Grade VI SLOs

Bloom's Level	Frequency of SLOs	Percentage
Remembering	16	31%
Understanding	9	17%

Applying	24	46%
Analyzing	0	0%
Evaluating	1	2%
Creating	2	4%
TOTAL SLOSs	52	100%

Table no. 1.5 shows the number and percentage of SLOs according to Blooms levels got curriculum of grade VI. Majority Of SLOs (46%) were related to application, followed by 31% in remembering level. Only 6% SLOs belonged to HOTS (2% in evaluation and 4% creation).

Table 1.6 Analysis of Grade VII SLOs

Blooms Level	Frequency of SLOs	Percentage
Remembering	13	18%
Understanding	7	10%
Applying	45	63%
Analyzing	1	1%
Evaluating	3	4%
Creating	3	4%
TOTAL SLOS	72	100%

Table no. 1.6 shows the number and percentage of SLOs according to Blooms levels got curriculum of grade VII. Like grade VI, majority of SLOs (63%) were related to application, followed by 18% in remembering and 10% in understanding level. Over all 91% of SLOs were LOTs and only 9% SLOs belonged to HOTS (1% analysis, 4% in evaluation and 4% creation).

Table 1.7 Analysis of Grade VIII SLOs

Blooms Level	Frequency of SLOs	Percentage
Remembering	20	36%
Understanding	13	24%
Applying	16	29%
Analyzing	1	2%
Evaluating	3	5%
Creating	2	4%
TOTAL SLOS	55	100%

Table no. 1.7 shows the number and percentage of SLOs according to Blooms levels got curriculum of grade VIII. Grade VIII had highest proportion of remembrance related SLOs (36%), while grade 6 and 7 had 31% and 18% of same level SLOs respectively. Proportion of understanding related SLOs was also higher in grade 8 curriculum. Grade VIII curriculum had slightly higher proportion of HOTS (11%) as compared to 9% and 6% in grade VIII and VI curriculum respectively.

Table No. 1.8 Complete Analysis of Curriculum rom Grad VI-VIII

Sr.	Blooms Level	Frequency SLOs	Parentage
1	Remembering	49	27%
2	Understanding	29	16%
3	Applying	85	47%
4	Analyzing	2	1%
5	Evaluating	7	4%
6	Creating	7	4%
TOTAL SLOS		179	100%

Table no. 1.8 shows the aggregate frequency and proportion of SLOs according to Blooms taxonomy for all three grades. 90% of SLOs fall in LOTs category, while only 10% were of HOTS. Highest proportion of SLOs were related to application (47%) followed by 27% in remembering category. 16% SLOs were of understanding. Among the HOTS only 1% SLOs were of analyzing and 4% each for evaluation and creation category.

The results also show that the curriculum have only 1% to 2% focused on merging the 21st century interdisciplinary themes with the core contents of the subject like Financial, Economic, Business and Entrepreneurial Literacy, civic literacy, health literacy and environmental literacy.

4. DISCUSSION, STRENGTHS & LIMITATIONS, RECOMMENDATIONS AND CONCLUSION

4.1 Discussions

To the best of my knowledge this is the first study of its type not only in Pakistan but in region, which analyzes national curriculum. In this paper Pakistan's national curriculum of computer science for grade VI-VIII was evaluated based on frameworks adapted from Bloom's taxonomy. This study also evaluated adaptation of 21st century skills in national computer curriculum evaluate that whether the curriculum document merging the interdisciplinary themes with the core contents of the subject

We found out that proportion of SLOs meeting standards of HOTS was low in curriculum; only 10% of SLOs were of HOTS quality in all three years. While in individually grade 8 had highest HOTS related SLOs (11%) and grade 6 had lowest (only 6%). We found an increasing trend of HOTS from grade VI to grade VIII, proportion of HOTS 6, 9 and 11 for grade VI, VII and VIII respectively.

However, through extensive literature search we found many studies focusing on teacher trainings, teaching methodologies but there is dearth of literature regarding curriculum evaluation. Since we don't have any other regional or national comparisons of our results, we compared the results with text book evaluation. As text books are written on foundation of curriculum, so we believe this close possible comparison.

Study conducted in Iran by Ibrahim found only 2.2% of SLOs related to HOTS in history textbooks of 6th grade. Proportion of LOTS was higher in Iranian history text book (98%) as compared to our study (94%). Like our study Riazi and Mosalaejad (2010) also found higher proportion of the lower-order cognitive skills in Iranian high school and pre-university textbooks. So, our results show almost comparable proportion of HOTS with Iranian text books.

4.2 Strengths and Limitations

Strengths of the study are:

- Use of Bloom's taxonomy
- P21 Framework for 21st century skills
- Reviewed national curriculum

Following are the limitations of study:

- Reviewed only national curriculum, can be expanded to review provincial curriculum, as in post 18th amendment scenario provinces have autonomy to make their own curriculum
- Text books of grade VI-VIII can be reviewed to assess if books are aligned with curriculum.

4.3 Recommendations

- Redesign the curriculum and includes the SLOs which based on analyzing, evaluating and creating levels of Bloom's Taxonomy which supports the development of higher order thinking skills among the students.
- Trained the teachers for teaching of HOTS.
- Change the traditional assessment standards and bring variety in assessment techniques.
- Include sample activities and teaching strategies in guidelines for textbook author section of curriculum which supports the development of HOTS among students and fulfill their diverse needs.
- Include the SLOs which merge the 21st century interdisciplinary themes with the content of subjects where appropriate. For example, mention SLOs which merges the concept of financial literacy in Unit No. 3 Spreadsheet in Excel of grade-VIII.

Before redesigning curriculum, a need analysis study will be helpful determine the need and willingness of teachers to develop HOTS in the computer curriculum.

4.4 Conclusion

This research study will become an input for redesigning the National Curriculum for Computer Education for grade VI-VIII which includes the SLOs based on analyzing, evaluating and creating levels of Bloom's Taxonomy which supports the development of higher order thinking skills among the students and merge the 21st century interdisciplinary themes.

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