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INVESTIGATING HOW BLOOM'S DIGITAL TAXONOMY INFLUENCES STUDENT LEARNING COMPETENCIES IN THE CLASSROOM

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Abstract

Bloom's Taxonomy, established by Benjamin Bloom in 1956, categorizes educational objectives into six cognitive stages. Anderson and Krathwohl revised it in 2001 to include Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating. Verbs are used to describe cognitive processes in the revised model, widely applied in designing learning objectives and promoting higher-order thinking skills. Bloom's Digital Taxonomy by Andrew Churches in 2008 integrates digital tools into education to address the importance of technology in learning. It encourages the use of technology to enhance cognitive processes at different levels. This study investigates the impact of technology integration into Bloom's Taxonomy on secondary school students' learning competencies through a quantitative survey with 211 students from Jamia.

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Findings from the survey, analyzed through PLS SEM-4, suggest that technology integration enhances various cognitive skills. There is a strong correlation (0.630) between Bloom's Digital Taxonomy and students' learning competencies. The study concludes that technology integration improves cognitive skills and prepares students for future success but highlights the importance of balanced use of digital and traditional methods. In summary, Bloom's Digital Taxonomy enhances learning outcomes and supports essential 21st-century skills for a progressive future.

Key words: Blooms Taxonomy, digital Taxonomy, Learning Competency

Introduction

Bloom's Taxonomy is a widely recognized framework that classifies educational objectives into different levels of cognitive complexity. It was developed in 1956 by Benjamin Bloom, an American educational psychologist, and his colleagues at the University of Chicago (Bloom et al., 1956). Six hierarchical stages made up the original taxonomy: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. Bloom's Taxonomy has been widely adopted in educational settings as a framework for designing learning objectives, instructional activities, and evaluation. It provides a structured way to ensure that students are exposed to different levels of cognitive demand and develop higher-order thinking skills (Krathwohl, 2002). By aligning instructional methods and assessments with the appropriate levels of the taxonomy, educators can create learning experiences that challenge students to progress from basic knowledge acquisition to more complex cognitive processes, such as analysis, evaluation, and creation (Krathwohl, 2002).

The Knowledge level represents the most basic form of cognitive ability, which involves recalling or recognizing information. The Comprehension level involves understanding the meaning of the information and being able to interpret or explain it. The Application level requires applying the acquired knowledge and comprehension to solve problems or address practical situations (Krathwohl, 2002).The Analysis level involves breaking down complex information into its components and understanding the relationships between them. The Synthesis level requires combining different elements or ideas to create something new or restructure existing knowledge. The Evaluation level, which is the highest level of cognitive ability, involves making judgments or decisions based on specific criteria or standards (Anderson & Krathwohl, 2001).

In 2001, Lorin Anderson and David Krathwohl presented a revised edition of Bloom's Taxonomy., which updated the terminology and emphasized the use of verbs to describe the cognitive processes. The revised taxonomy includes Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating as the six levels (Anderson & Krathwohl, 2001).The Remembering level corresponds to the original Knowledge level, while Understanding replaces Comprehension. The Applying level remains unchanged, and analyzing corresponds to the original Analysis level. The Evaluating level is similar to the original Evaluation level, and creating replaces the Synthesis level (Krathwohl, 2002).

Applications of Bloom's Taxonomy in A Classroom

Bloom's Taxonomy provides a structure for designing instructional activities and assessments that align with different levels of cognitive complexity. Here are some applications of Bloom's Taxonomy in a classroom setting, Teachers can use Bloom's Taxonomy to develop learning objectives that target different cognitive levels, from higher-order abilities like analysing, assessing, and developing to lower-order abilities like remembering and understanding (Shabiralyani et al., 2015). Bloom's Taxonomy can guide teachers in formulating questions that promote different levels of thinking, from simple recall questions to more complex questions that require analysis, synthesis, and evaluation (Eber & Parker, 2007). Teachers can design activities and tasks that correspond to the numerous Bloom's Taxonomy stages. For example, activities at the lower levels might involve reading, summarizing, or practicing skills, while higher-level activities could involve problem-solving, decision-making, or creating original work (Buskist& Irons, 2008). Different cognitive levels can be measured using assessments that are based on Bloom's Taxonomy. Lower-level assessments might include multiple-choice questions or short-answer questions (Remembering and Understanding levels), while higher-level assessments could involve essay questions, case studies, or projects (Analyzing, Evaluating, and Creating levels) (Lipschutz & Griese, 2009).

By incorporating Bloom's Taxonomy into lesson planning, questioning strategies, instructional activities, and assessments, teachers can ensure that students are exposed to a range of cognitive demands and develop higher-order thinking skills, which are essential for success in academic and professional settings (Shabiralyani et al., 2015).

Bloom's Digital Taxonomy

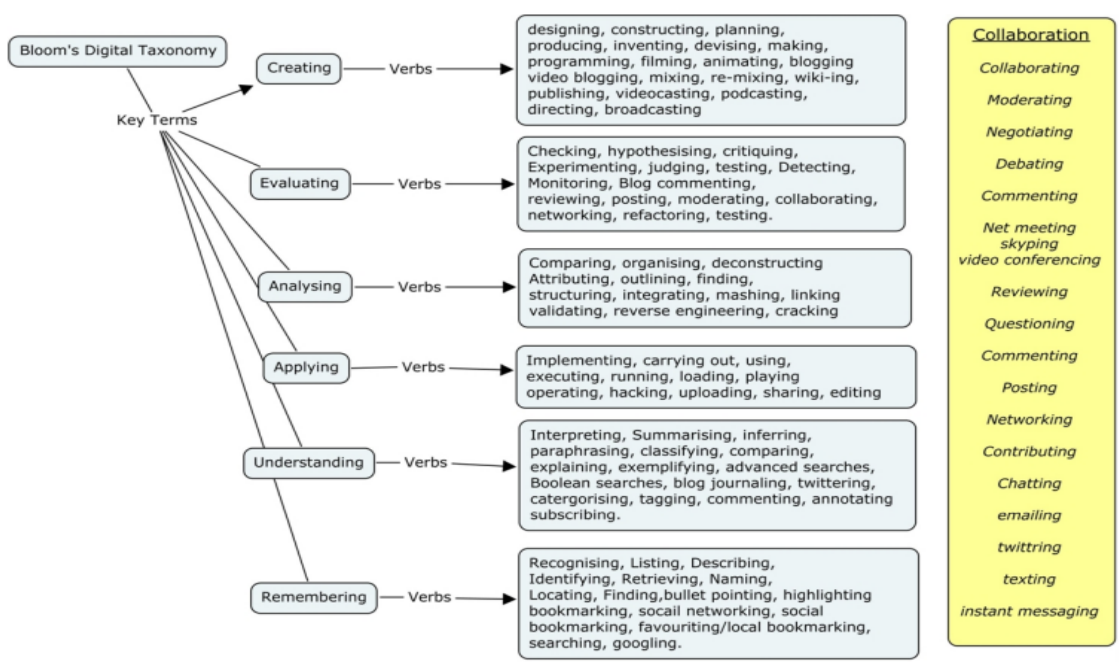
The Similar to the original taxonomy, learning objectives may be created using lists of related verbs provided by Bloom's Digital Taxonomy for instructional designers. As they create content, they can advance from lower-order skills like term definition and memory to higher-order skills like applying knowledge to novel contexts, seeing connections between concepts, and assessing and analysing information to form judgements or establish the accuracy of the content.

In 2008, Andrew Churches created a version called **Bloom's Digital Taxonomy** The digital taxonomy incorporates verbs and proposed activities related to e-Learning and other online learning and exploration methods, as well as tasks used for digital learning and creation.

Figure by A. Churches created using c-map tool

Bloom's Digitalized Taxonomy in A Classroom

In today's technology-driven world,



Drawing 3: Mind map of Bloom's Revised Digital Taxonomy

incorporating digital tools and resources into the classroom has become increasingly important. Bloom's digital taxonomy provides a structure for creating learning activities that integrate digital technologies and foster higher-order thinking skills among students. By aligning concepts with the various levels of the digital taxonomy, educators have the power to provide effective and interesting learning opportunities that will equip students for success in the 21st century.

At the remembering level, students can utilize digital resources to recall and recognize facts, formulas, and procedures. This can be facilitated through interactive online quizzes, flashcard apps, or digital math drills. For example, students can access online repositories of concepts, definitions, and examples to strengthen their foundational knowledge. The understanding level involves comprehending concepts and principles. Digital tools can aid in this process by providing visual representations, simulations, and interactive models. For instance, students can use dynamic geometry software or virtual manipulatives to explore geometric shapes, transformations, and their properties. Online videos and multimedia presentations can also help students grasp abstract concept through clear explanations and real-world examples. To solve problems and complete tasks. Digital tools can offer a wide range of problem-solving opportunities and real-world applications. For example, students can use spreadsheet software or online calculators to analyze data, create charts, and interpret mathematical models. Additionally, they can engage with interactive math websites or mobile apps that provide practice problems and immediate feedback. The analyzing level requires students to break down problems into components, identify patterns, and find relationships. For instance, students can use these tools to analyze functions, examine trends in data sets, and recognize patterns in mathematical expressions. Digital platforms can facilitate peer review and collaborative assessment of mathematical work. Students can use online forums, discussion boards, or collaborative writing tools to provide feedback on each other's solutions, reasoning, and arguments. Additionally, they can evaluate the credibility and relevance of digital resources using established criteria. The creating level involves using digital tools to design, construct, or produce new products or representations. Students can utilize presentation software, video editing tools, or coding platforms to create multimedia presentations, animations, or simulations that demonstrate their understanding of concepts. They can also design and develop their own digital math games, interactive tutorials, or educational resources, showcasing their creativity and mastery of over concepts.

Throughout the implementation of Bloom's digital taxonomy in the classroom, it is essential to Provide students the chance to work together, develop critical thought, and solve problems. Digital tools can facilitate group work, peer feedback, and communication, fostering a collaborative learning environment where students can share their understanding and learn from one another. Additionally, incorporating authentic and real-world applications can enhance the relevance and engagement of learning activities. By integrating digital tools that simulate real-world scenarios or allow students to analyze and interpret real-world data, educators can create meaningful learning experiences that prepare students for future academic and professional pursuits.

Ultimately, the effective application of Bloom's digital taxonomy in the classroom requires careful planning, appropriate selection of digital tools and resources, and a strong emphasis on developing higher-order thinking skills. By aligning content with the cognitive processes outlined in the digital taxonomy, educators have the ability to design dynamic and engaging environments for learning that promote students' digital literacy, problem-solving skills, and critical thinking.

Review of literature and proposed hypothesis

Dyer and Osborne (1995) posited that choosing a suitable method of instruction is a crucial procedure for achieving teaching success and student accomplishment. Dyer and Osborne, (1995) demonstrated further that pupils react differently to different teaching strategies, emphasizing the criticality of selecting the suitable techniques aligned with learners' preferred styles (p. 260). Literature reviews indicate the prevalent use of videos for extracurricular teaching, while interactive activities involving active student engagement are favoured for in-classroom instruction (Hsu, 2017; Lage et al., 2000; Roehling et al., 2017; Song & Kapur, 2017; Zengin, 2017; Basal, 2015; Graziano, 2017; Herreid & Schiller, 2013).

The utilization of videos that captivate students' focus and aid in content absorption can promote active participation and student-centered learning (Herreid & Schiller, 2013). Instructors leverage technology by producing video materials and incorporating freely available online videos to enhance the teaching process (Sherer & Shea, 2011). Current research has scrutinized the Flipped Classroom Model's (FCM) effects on motivation, performance, learning outcomes, and student engagement, with findings suggesting that the FC approach bolsters academic achievement (Baepler et al., 2014; Davies et al., 2013), elevates learning achievements (Chen Hsieh et al., 2017; Gillispie, 2016), and enhances learners motivation (Chyr et al., 2017; Graziano, 2017). Despite the majority of research supporting the positive impacts of the FCM on the education of learners, some studies have not confirmed the expected benefits. For instance, Smallhorn (2017) did not identify a noticeable improvement in students' academic performance. Similarly, Kim et al. (2014) found no evidence linking the FCM to enhanced student grades. Zengin (2017) that integrated the FCM with Khan Academy and open-source software. This study aimed to assess the FCM's impact on academic accomplishments and gather student perspectives on this instructional model (Zengin, 2017). 28 students from a Turkish public university's Mathematics Teaching Program participated in the study, revealing that the FC learning environment, incorporating Khan Academy and math software, led to a twofold increase in students' academic success. Furthermore, this approach was found to facilitate learning, support visualization in math education, and promote enduring comprehension (Zengin, 2017).

Proposed hypothesis

H01(a) integration of technology in blooms taxonomy enhance the creativity of the learner's

H01(b) integration of technology in blooms taxonomy enhance the remembering of the learner's

H01(c)integration of technology in blooms taxonomy makes the concept more comprehensive to understand

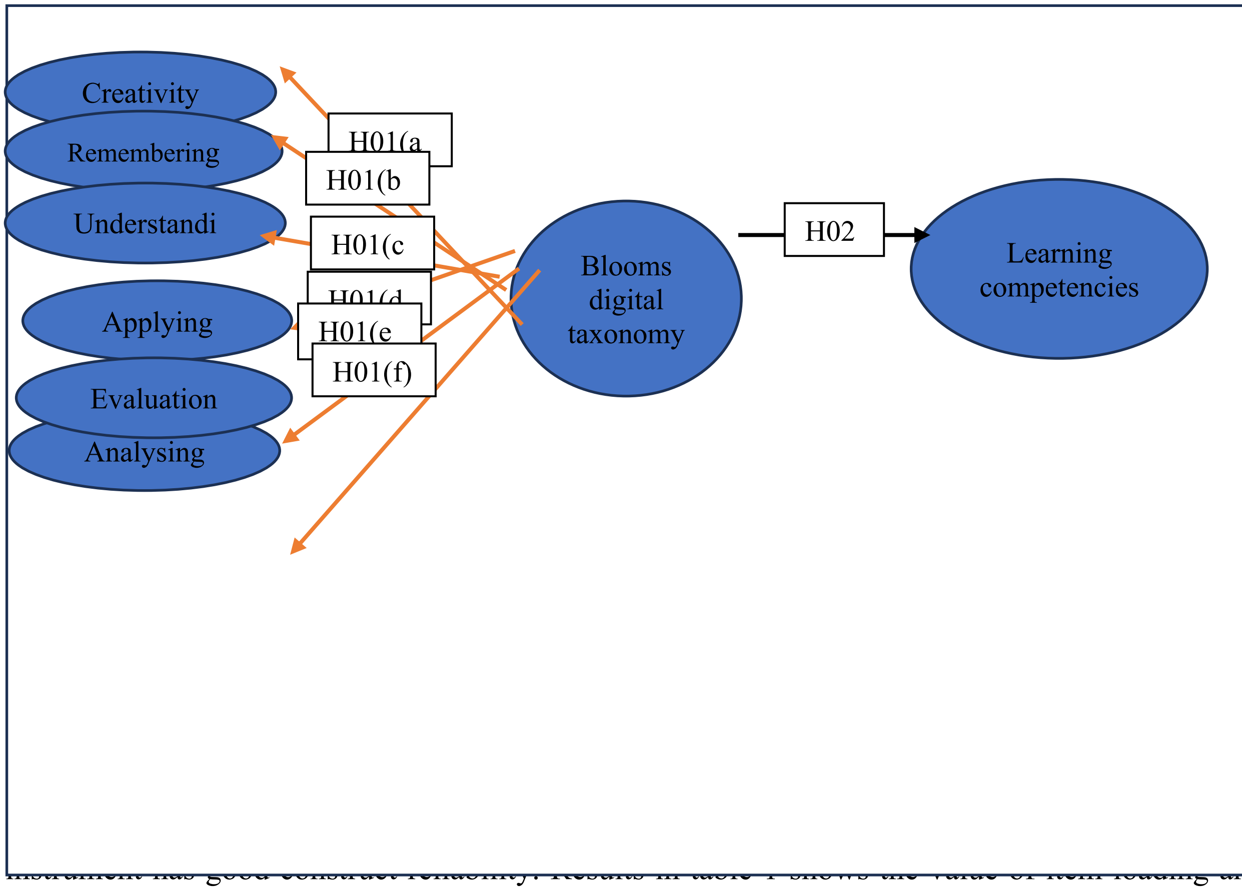
H01(d) integration of technology in blooms taxonomy helps the learners applying the gained knowledge in real life scenario

H01(e)integration of technology in blooms taxonomy dissect information and explore underlying patterns and relationships

H01(f) integration of technology in blooms taxonomy promote critical evaluation of ideas, encouraging students to justify their reasoning

H02: integration of blooms digital taxonomy significantly effects the learning competency of the learner

Proposed model



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reliability and Cronbach Alpha values of each construct.

Table 1: outer loading, composite reliability and Cronbach alpha

Items and constructs	Outer loading	Cronbach α	CR	AVE
Creativity		0.875	0.879	0.800
CRE1	0.912			
CRE2	0.894			
CRE2	0.877			
REMEMBERING R		0.890	0.891	0.820
REM1	0.820			
REM2	0.803			
REM3	0.845			
UNDERSTANDING		0.841	0.848	0.758
UND1	0.895			
UND2	0.867			
UND3	0.849			
APPLYING		0.864	0.864	0.786
APL1	0.882			
APL2	0.892			

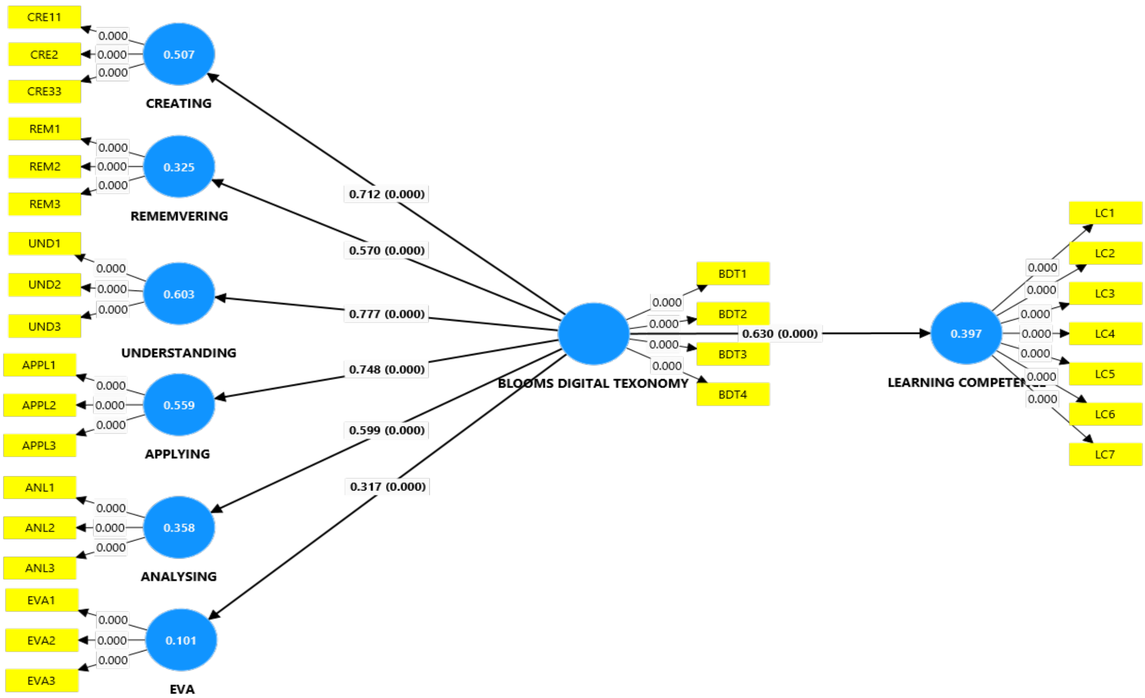
APL3	0.885			
ANALYSING		0.835	0.836	0.752
ANA1	0.882			
ANA2	0.855			
ANA2	0.864			
EVALUATING		0.789	0.833	0.700
EVA1	0.774			
EVA2	0.841			
EVA3	0.891			
BLOOM DIGITAL TEXONOMY		0.867	0.867	0.716
BDT1	0.835			
BDT2	0.860			
BDT3	0.878			
BDT4	0.809			
LEARNING COMPETENCIES		0.909	0.915	0.647
LC1	0.820			
LC2	0.803			
LC3	0.845			
LC4	0.780			
LC5	0.799			
LC6	0.833			
LC7	0.747			

Discriminant Validity

Fornell- Larcker Criteria for discriminant validity

	ANAA	**APP**	**BDT**	**CRE**	**EVA**	**LC**	**REM**	**UND**
ANA	0.867							
APP	0.556	0.887						
BDT	0.599	0.748	0.846					
CRE	0.521	0.705	0.712	0.895				
EVA	0.292	0.465	0.317	0.413	0.837			
LC	0.419	0.588	0.630	0.584	0.620	0.804		
REM	0.323	0.460	0.570	0.474	0.278	0.441	0.906	
UND	0.592	0.745	0.777	0.708	0.483	0.695	0.451	0.871

Structural Model



From the structural model it shows that on the integration of technology in blooms taxonomy enhance the learning outcome of the learners. There is strong correlation i.e. 0.630 between blooms digital taxonomy and learning competencies of the learners. If technology is integrated in classroom, it will be helpful in retaining the concept of the learners.

HYPOTHESIS TESITNG

Table 3: hypothesis testing

SN	Hypothesis	Relation	β- Value	Std error	t-value	p-value
1.	H01(a)	BDT-CRE	0.712	0.041	**20.223**	0.000
2.	H01(b)	BDT-REM	0.570	0.051	**11.212**	0.000
3.	H01(c)	BDT-UND	0.777	0.039	**20.125**	0.000
4.	H01(d)	BDT-APL	0.748	0.037	**20.223**	0.000
5.	H01(e)	BDT-ANA	0.599	0.065	**9.264**	0.000
6.	H01(f)	BDT-EVA	0.317	0.067	**20.223**	0.000
7.	H02	BDT-LC	0.630	0.057	**11.027**	0.000

To test the proposed hypothesis, we use PLS SEM 4.1 software bootstrapping function. And the results of the test are mentioned in table 3. Showing that blooms digital taxonomy enhances the creativity, improve remembering, help in understanding the concept, applying the learnt concept in real life situations, dissect information and explore underlying patterns and relationships and promote critical evaluation of ideas, encouraging students to justify their reasoning supporting the hypothesis H01(a), H01(b), H01(c), H01(d), H01(e), H01(f). furthermore, the blooms digital taxonomy helps the learners in developing learning competencies which support hypothesis H02.

Conclusion

Technology in all the sector of life is influence life of human being. the learning teaching in higher level as well as school level also influenced by the technology. Number of researches have already shown the effect of technology in education sector. In the present study the researcher tries to find out the integration of technology in blooms taxonomy which focused on six factors namely creativity, remembering, understanding, applying, analysing and evaluating. Integration of technology directly enhance the creativity, improve remembering and help the learners to understanding the context in comprehensive way. It also helps utilizing the learned knowledge in real life situations and finally evaluating the learners by self. Furthermore, blooms digital taxonomy helps in developing the learning competencies among the learners which are essential for 21st century learners as well as to achieve the goal of Vikshit Bharat in 2047.

Limitations

While Bloom's digital taxonomy offers a valuable framework for incorporating technology into the mathematics classroom, it is essential to acknowledge and address its potential limitations specific to the subject area. Here are some considerations:

Digital tools and resources may not always align seamlessly with the logical progression and prerequisites required for effective learning. Careful curation and integration of digital resources are necessary to ensure they complement the curriculum appropriately.

Furthermore, an over-reliance on digital tools could potentially hinder the development of essential mathematical skills, such as mental calculation, algebraic manipulation, or logical reasoning. A balanced approach that incorporates both digital and traditional practices is crucial to foster a well-rounded understanding of mathematics.

Additionally, the digital taxonomy may not adequately take into account each student's specific learning preferences and needs in a s classroom. While some students may thrive with digital resources, others may require more personalized attention or alternative instructional methods to grasp concepts effectively.

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Questionnaire

BDT

1. Information technology enhances student academic performance. (Bowling, 2015).
2. It helps students access necessary information easily. (Bowling, 2015).
3. Utilization of IT improves operational efficiency and processes. (Aisiyah & Noorbaity. 2011).
4. Information technology in learning caters to various senses of students. (Rusman, 2011).

Remembering:

5. ICT aids help me to recall facts and concepts
6. ICT assist me identifying key terms or elements
7. ICT boost my Confidence in remembering concepts

Understanding:

8. ICT supports me in Explaining main ideas in own words?
9. ICT assist me in Interpreting graphs, charts, or diagrams.
10. ICT develop Confidence in summarizing key concepts of

Applying:

11. ICT assist me in using principles of new situations?
12. ICT support Comfort in applying concepts to solve problems?
13. ICT help me Demonstrating practical application of in real-life scenarios?

Analyzing:

14. Utilising ICT I can break down complex information effectively?
15. ICT helps me in develop Confidence.
16. ICT Differentiate between aspects or viewpoints

Evaluating:

17. With the help of ICT Ability to assess validity and credibility of sources
18. It develops Confidence in critiquing arguments or solutions.
19. ICT Judge effectiveness of strategies used in various subjects.

Creating:

20. ICT helps in Innovativeness in generating new ideas.
21. With the help of ICT Designing original projects effectively?
22. Using ICT I create novel approaches for addressing challenges.

Learning competencies in mathematics

23. I effectively demonstrate the key concepts and principles in various subjects
24. I can apply learned knowledge and skills to solve daily life situations or complete tasks independently

25. I confidently communicate ideas, thoughts, and findings
26. am proficient in critically analyzing and evaluating information or arguments
27. I feel a great ease in demonstrating creativity and innovation in approaching assignments or projects
28. In gives me immense pleasure when I collaborate with peers or team members to achieve shared goals or complete group tasks?
29. how would you rate the technology helps you in understanding and remembering concepts