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Comparing the Higher Order and Lower Order Learning Factors in the Cognitive Domain Learning Attainments of Students

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Abstract

This research investigates the variances in the attainment of students in the cognition levels: lower-order learning (LOL) and higher-order learning (HOL). This is important because it helps improve teaching methods tailored to the discipline. The cognitive domain of Bloom's Taxonomy has six layers: the first three – remembering, understanding, and applying – are considered LOL, while the other three – analyzing, evaluating, and creating – are regarded as HOL. The primary focus of this research is on student learning—specifically how it varies when exposed to different levels of cognitive demand in various disciplines. Teaching strategies are considered only as they influence learning outcomes. To compare students' learning under LOL and HOL, an answer was sought to the question, "Does the students' learning vary by LOL and HOL in diverse disciplines?" The study intricate 340 undergraduate students enrolled in five selected courses of five programs of various disciplines in Bangladesh and Thailand. HOL achievements were always strongly and positively dependent on those in LOL. Learning patterns among students aged 22-26 years were found to be similar. The study can be used by academicians as its findings provide evidence for comparing data between LOL and HOL of the students, which can notify educators to balance the cognitive levels in their efforts to make them employable and lifelong learners.

1. Introduction

The changes in job market demands and essentially the skills required for jobs are the trends in all jobs as outlined in the World Economic Forum's The Future of Jobs Report 2023. According to the employers' estimation, 44% of the workers' skill sets

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will be reshaped. The fastest growing and most important skill is cognitive skills, among all required skills, which are followed by creative thinking, analytical thinking, technology literacy, and so on (WEF, 2023). This shift compels educational institutions to reevaluate how students are taught and assessed, particularly in terms of cognitive engagement across disciplines. The report has also stated that 6 out of 10 existing workers worldwide need training before 2027 to perform their duties on the job effectively. Improvement in the education system has the highest priority in the public policy demand, as a proper education may produce graduates ready for the job with the necessary skills, including cognitive ones. Educational institutions, along with pragmatic curricula and effective teachers, play significant roles as change makers to support the public policies and the situation in demand. Teaching is not about leading a student through lecture activities or lessons delivered in a closed classroom; instead, it has to be ensured through collaborative and diverse approaches. In addition, curricula must foster capacities for discernment and the sincere investigation of complex truth (UNESCO, 2021). One important principle in curricula is that the global knowledge commons expect all to have a right to accurate knowledge that contributes to human well-being. In this reality, there is no alternative to appreciating the expected skills of students' learning in the cognitive domain. Students need to excel in both hands-on and emotional skills to perform in their professional lives effectively.

Therefore, the Cognitive domain is tied up with the other two learning domains: Psychomotor and Affective respectively. These are the three domains of teaching-learning activities first introduced by the psychologist Benjamin Bloom, widely known as Bloom's Taxonomy (Bloom & Krathwohl, 1956). This taxonomy was revised later by Bloom himself with his students and associates, the latest of which was published in 2001. A detail of this taxonomy is described in the Literature Review section, which has been the foundation of the pedagogical terminology, Outcome-Based Education (OBE). The main philosophy of OBE is that education must be helpful for the betterment and sustainability of the human race in the world. OBE will have clearly defined learning outcomes to be taught by pre-planned and well-informed methods so that the students' attainments will ultimately be measured with a proper assessment tool (Spady, 1994). Thus, it is not an alien idea. Instead, it aligns with other reports and expectations regarding the usefulness of education, which can ultimately be identified as beneficial to societies.

The significance of this research lies in its potential to inform discipline-specific teaching strategies. For example, science education often requires students to hypothesize and experiment (HOL), while introductory business courses may emphasize memorization of terminology (LOL). Without understanding how students respond to these cognitive demands, educators risk misaligning instructional methods with learning needs, leading to ineffective teaching and poor student outcomes. This study focuses on the cognitive learning domain when the students are deliberately taught under the teaching-learning approaches by the factors of LOL and HOL in different subject areas. The research leads to answering the question "Does the students' learning vary by LOL and HOL in different

disciplines?" The OECD (2023) highlights that while online and blended learning environments show promise for fostering HOT, their effectiveness varies across disciplines and contexts. This reinforces the need for research that examines how LOL and HOL impact learning in specific subject areas.

This research addresses the following issues:

(1) Disciplinary variation: How do LOL and HOL affect learning differently in fields such as STEM, humanities, and vocational education?
(2) Instructional design: What teaching methods best support HOL in disciplines that demand it?
(3) Assessment alignment: How can assessments be tailored to reflect appropriate cognitive levels?

The following sections of the article include a relevant literature review, methodology of the research, summary of the key findings, discussions on results and the probable impact of the study with concluding remarks.

2. Literature Review

In recent years, there has been a growing trend of education-related research on the significance of teaching higher-order thinking to equip students with the ability to solve complex problems in the 21st century (Kivunja, 2015). Indeed, today traditional methods might be the common approach to graduating a particular course, but not being prepared for the complexities, such as problem-solving, collaboration, and adaptability (Treve, 2024). However, the interaction between the lower and higher-order thinking processes is still complicated and the basic knowledge is a requisite of the more advanced thinking process (Willingham, 2007).

Several researchers have found positive relations between the development of higher-order thinking skills and academic performance improvement in diverse fields. Zohar and Dori (2003) compared high school students in a longitudinal study of 1,080 students, and reported that explicit learning on higher-order thinking skills showed significantly better performance in standardized tests than traditional instruction approaches. In the same manner, Heong *et al.*, (2011) examined the correlation between higher-order thinking performance and academic performance in a group of 250 students of technical education providing significant positive correlations between the higher-order thinking skills and the overall academic performance ($r = 0.67$, $p < 0.01$).

Among various educational theories developed to make our learners adequately prepared for the future, Outcome-Based Education (OBE) has been chosen for the literature of our research. The four principles of OBE were developed from the Mastery Learning instruction model proposed by Benjamin Bloom in 1968 (Spady, 2020). Mastery Learning instruction was modelled in light of the educational taxonomy that is widely known as Bloom's Taxonomy.

Another thought, similar to the subject matter, called the cognitive load theory presented by Sweller (1988) also gives more theoretical background to the relationship between various cognitive processes. The theory proposes the existence of barriers to the working memory capacity of human cognitive architecture that influence the ability to learn. This model can be used to understand the reasons why low-order cognitive skills can be automated processes and free cognitive capacities to think at a higher level (Sweller *et al.*, 2019). However, we have dived deep into Bloom's Taxonomy for further details.

2.1 Bloom's Taxonomy

In 1956 and subsequent years, Bloom and some scholars developed deeper and more complex forms of thinking, application, analysis, and assessment strategies aimed at categorizing educational goals and objectives across different disciplines and academic levels. It was initially designed to classify learning objectives in the cognitive domain, focusing on intellectual skills. Later, the Affective Domain (1964) and Psychomotor Domain (1970s) were introduced to encompass the aspects of emotional and physical learning. The taxonomy was revised in 2001 by Lorin Anderson and David Krathwohl, shifting the cognitive domain's highest level from Synthesis to Creation. The cognitive domain focuses on the changes in learners' cognition because of learning. The psychomotor domain emphases the achievement of hands-on skills of the learner or their capability of doing something. The affective domain focuses on the changes in the emotional state of the learner or the building of their expected mindset from learning. The latter two domains are eventually based on the first one. Without gathering information that leads to changes in a learner's cognition, psychomotor skills, and/or affective abilities, they cannot be achieved.

Cognitive domain layers

Cognitive Domain of Bloom's Taxonomy: consists of six categories (C1) Remembering, (C2) Understanding, C3 (Applying), c4 (Analyzing), c5 (Evaluating), and c6 (Creating). This structure is hierarchical, with lower learning serving as the platform for higher-order learning (Shah & Zakaria, 2024). Lower-order learning is essential for building the foundational knowledge, which involves basic remembering and understanding, which are essential for in-depth learning. For example, students need to remember and understand the facts first so that later they can apply, analyses, or evaluate them (Hashim & Ahmed, 2021). Applying and Analyzing are sometimes considered middle-order learning, while evaluating and creating layers are in the higher order. The three base-layers (C1) Remembering, (C2) Understanding and (C3) Applying are considered lower-order learning in the Understanding and Application Knowledge Network (UAKN), while the other three layers (C4) Analyzing, (C5) Evaluating and (C6) Creating are considered higher-order learning in the Analysis and Evaluation Knowledge Network (AEKN) (Zou et al., 2023). In this research, the authors adopted this categorization and accordingly, C1-C3 layers are taken under lower order learning (LOL), and C4-C6 are taken under higher order learning (HOL).

But, emphasizing too much lower-order learning can be limiting for students. In assessments and pedagogical practices, more weight is given to lower-level learning and therefore arguably constrains the development of critical and problem-solving skills (Stringer *et al*, 2021; Agarwal, 2019).

Engaging students in higher-order learning activities has been demonstrated to enhance students' academic experience and satisfaction. In a study in which they compared undergraduates engaging in HOL activities to those performing LOL in the same category, HOL participants experienced greater levels of satisfaction and motivation. (Shcheglova *et al*, 2024).

Deeper cognitive activation and the realization of critical thinking, creativity more visible marks solving competencies in action with higher-order learning. Research has demonstrated that students who are involved in HOLTs not only achieve higher academic performance but also are more satisfied with their learning (Shcheglova *et al.*, 2024; Teemant *et al.*, 2016).

For example, one such study found that learners whose teachers frequently employed higher-order strategies experienced significant growth in terms of language arts achievement as well as English language proficiency (Teemant *et al.*, 2016).

Similarly, research on retrieval practice suggests that engaging in higher-order learning tasks enhances long-term retention and understanding compared to rote memorization (Agarwal, 2019).

Cognitive domain in Mathematics, Nursing and Business

The cognitive sphere is integral to how students experience learning in fields such as mathematics, nursing, and business. Cognitive skills, such as those required for problem-solving, logical understanding, and numerical knowledge, are necessary for students to be successful in learning mathematics and there is research pointing to the important role of skills with symbolic numbers and language comprehension in doing mathematics successfully (Amland *et al.*, 2025). In the same sense, critical thinking, clinical reasoning, and decision- making as cognitive skills are inherent in the purpose of education in nursing as they allow nurses to make sense of complex medical information and to use evidenced based practice (Benner, 2024). The nursing process is widely believed to correspond to the cognitive domain of Bloom's Taxonomy. Both emphasize critical thinking and problem solving (Anderson & Krathwohl, 2001). Similar to the cognitive domain, the nursing process consists of the phases of assessment, diagnosis, planning, implementation, and evaluation (Potter *et al.*, 2021). Throughout the assessment phase, nurses gather data from patients. This information is associated with the knowledge and comprehension phases of Bloom's taxonomy model. In the diagnosis and planning phases, nurses "apply and analyses" the data "through the use of logic". As a result, knowledge must be applied to implement. "We have been asked to judge the quality of care…" Bloom's Taxonomy directs the evaluation phase. On top of that, Bloom's levels of cognition can be used for each step of the nursing process to ensure comprehensive

and quality care is delivered to patients (Forehand, 2010). Business students depend on, often exclusively, cognitive domain skillsets, such as strategic and financial planning and management decision-making for functioning in ever-changing market situations (Robinson & Brown, 2023). Also developing students' cognitive domain engages them in rigorous analysis, empowers them to be effective problem solvers, and provides a skill set for students to be professionals in these fields, thereby attesting to the need for higher education and job preparedness.

Learning in the cognitive domain also varies according to the instructional approach, the individual's cognitive capabilities, and levels of engagement. Studies have shown that learning by doing rather than simply lecturing leads to better cognitive outcomes, including more recent research showing better development from inquiry-based learning and from learning through games (Hii *et al.*, 2023). For instance, gamification enhances learning by creating knowledge and problem-solving acquisition through interactivity that leads to cognitive engagement (*Hii et al., 2023*). Also, computational thinking approaches advance engagement of higher-order cognitive skills in STEM learning experiences by having students learn how to analyses and solve problems from doing structured programming exercises (Jin & Cutumisu, 2024). Cognitive strategies are also evidenced by meta-cognitive strategies, where students are taught to control their learning processes and improve outcomes in school (Nordin, 2021). This shows the role of the teacher in disposing the child towards specific types of cognitive development and learning optimally in given circumstances.

2.2 Outcome-Based Education

Renowned educator William Spady said that if the four principles aren't followed consistently, systematically, creatively and simultaneously, then it isn't Outcome-Based Education (OBE) (Spady, 2020). OBE is based on four principles:

(i) A clear set of learner Outcomes is established by the educators, which forms the basis for all systems of instruction and assessment.

(ii) Educators believe in and live the OBE's 'Success for All Learners' Philosophy and Pillars of Power working together.

(iii) Educators match and combine these two elements with the content-referenced, criterion-referenced Foundation of learning and performance Standards of OBE.

(iv) Educators dramatically change their Paradigm thinking, Priorities, and how they operate from time-centered to outcomes-centered.

Educators' role is clearly visible in Spady's OBE principles with the highest significance. Here, the educators are primarily the teachers. Curriculum design and assessment practices also significantly influence whether higher-order learning is promoted. Many curricula and assessments remain heavily focused on lower-order learning, with higher-order learning often underrepresented. It also promotes a more learner- cantered approach to learning in which teachers prepare students by

teaching them skills of critical thinking, problem solving, and applying knowledge (Biggs & Tang, 2011). Plus, OBE is internationally a popular approach in higher learning institutions because it improves employability and preparation for careers.

In order for OBE to be effectively adopted there must be an organized process for the assessment of students' learning outcomes. Formative and summative assessment is key. Also, as feedback is a tool of OBE, "there is an opportunity for ongoing refinement of the curriculum as teachers begin to receive evidence on how well students are achieving" (Killen, 2007). It has been found that OBE also heightens student engagement and motivation because students become invested in a goal-based education that is relevant to their chosen careers (Malan, 2000). As systems of education globally shift in this ever-changing world, the infusion of OBE principles will remain a critical way to enable lifelong learners who have the skills to flourish.

Similarly, a study on English exams at the primary level in Rwanda revealed that 98.79 of the questions were focused on LOL skills and only 1.21 on HOL skills (Muhayimana *et al.*, 2022). OBE is a process of evolution which helps to enhance the quality of the programs and graduates by helping the students to develop multiple capabilities at different levels and ensuring effective measurement of their performance (Barradell, 2012; Gunarathne *et al.*, 2019). OBE also increases levels of student engagement, motivation and performance by making the learning experience more engaging because students are able to see the relevance and purpose of what they are studying (Wang, 2023; Saha *et al.*, 2023). OBE fosters engaged and participatory students typically through projects, problems and applications in the world around them (Ohatkar & Deshpande, 2022; Jiang *et al.*, 2022).

2.3 Teacher's Role for Better Learning

The role of teachers in the 21st century has evolved significantly, requiring educators to adopt dynamic teaching styles that promote critical thinking, collaboration, and adaptability.

Student-centered approaches, like inquiry-based learning, flipped classrooms, and experiential learning, which are designed to create a higher level of engagement and knowledge retention than the traditional lecture method, are becoming more common in libraries and library schools (Bonner, 2021). The teacher is the focal point of the classroom as he/she transmits information and guides learning activities (Ghafar, 2023).

However, many professionals face challenges in integrating higher-order learning into their instructional practices. In a study by Shah and Zakaria (2024) on Malaysian science teachers, teachers acknowledged the significance of higher-order learning but commonly restricted its application to high-ability students, thereby reinforcing a faulty perception that lower- ability students were not capable of higher-order learning. (Sabir *et al.*, 2024). In one study of coaching on higher order

learning, teachers who were coached to incorporate higher order learning in their classrooms did so and their students fared better as a result (Teemant *et al.*, 2016).

This shift requires teachers to be more flexible and adaptable, as well as more attuned to the individual needs and progress of their students (Aguilar, 2023). Another research highlights that effective teaching integrates technology, personalized instruction, and interdisciplinary learning to prepare students for complex real-world challenges (Toquero & Capistrano, 2024).

In addition, also the role of the teacher has also changed from being the only source of knowledge to being a guide that leads the students to engage in interactive and problem-solving tasks that promote autonomous learning and creativity (Rao, 2020). It reemphasizes the need of being flexible in one's pedagogy and having continuous professional development to meet the varied needs of the 21st century learner.

The teacher's role is also remarkable when the student's learning is intended to be higher-order. Especially when HOL is targeted, there are many variables that can contribute to students attaining higher-order thinking skills, but the most critical are lecturers' content delivery ability and the curriculum (Mazibuko & Maharaj, 2024). This research eventually converted the focus into the curriculum of Mathematics education, recognizing the equal importance of teaching styles.

A major benefit of contemporary teaching techniques correlates with how well instructors identify learners' preferences and adapt their instruction accordingly. Adaptive learning environments promote teachers' ability to adjust their methods and interventions based on formative assessment and students' perspectives (Wood & Sithamparam, 2021). Plus, the incorporation of digital materials and group learning made them more accessible and engaging, ready learners with communication, problem-solving, and digital literacy skills (Toquero & Capistrano, 2024). Modern teaching styles are effective when the teacher is able to evaluate and adapt their instruction to students' learning preferences. Through the use of formative assessments and learner feedback, adaptive teaching "allows teachers to engage in practice that refines their methods and focuses on the needs of individual learners" (Wood & Sithamparam, 2021). On top of that, new technologies and collaborative learning activities foster greater access and interest while also helping learners to develop important communication, problem-solving and digital competence skills (Toquero & Capistrano, 2024).

Education is constantly changing and teachers must use the new practices that will allow students to thrive in a globalized and technologically advanced world. Teachers may require additional training to apply their teaching practices effectively, and there can be variability in how cognitive levels are interpreted and assessed.

Rais *et al.*, (2021) indicate that it should be the priority for all parties involved including students, parents, employers and society in general to get quality education. In order to advance instructional practices and create learner-centered

teaching, institutions of higher education must cultivate learning communities of teachers and enhance teacher self-efficacy, Pan (2023) argues.

OBE is labelled a learner-centered approach. Another study has shown that when assessments are designed to target higher-order learning, students are more likely to engage deeply with the material and ultimately develop a better understanding of the subject matter (Chandio *et al.,* 2021).

In this literature review, it has been observed that multiple research works recognize OBE as a learner-centered teaching-learning approach that facilitates better student learning. Technology-enhanced teaching-learning amplifies the attainments in a positive direction. The cognitive domain in Bloom's Taxonomy serves as the foundation for implementing OBE in students' learning outcomes, making them fit for the changing global reality. In addition, multiple articles have also identified LOL as the base of HOL, according to the intended learning of the students. In this study, specific subjects are chosen to investigate students' attainment levels in terms of intended learning outcomes, categorized by LOL and HOL

3. Materials and methods

This is exploratory research for finding the learning attainments of the students. The whole study involved a step-by-step action performed by all of the authors.

3.1 Conceptual framework

Four authors of this article were involved in the research activity separately in three different institutions, teaching five different courses for students at the undergraduate level. The three institutions were at the higher education level in Bangladesh and Thailand. The subject disciplines and courses differed significantly in terms of teaching, learning, and assessment approaches. However, each of the research teachers made predefined plans for teaching their respective courses and ultimately assessing the students' performance at the end of the semester. Figure 1 represents the framework of the methodology of this research with explanations of each chronological step.

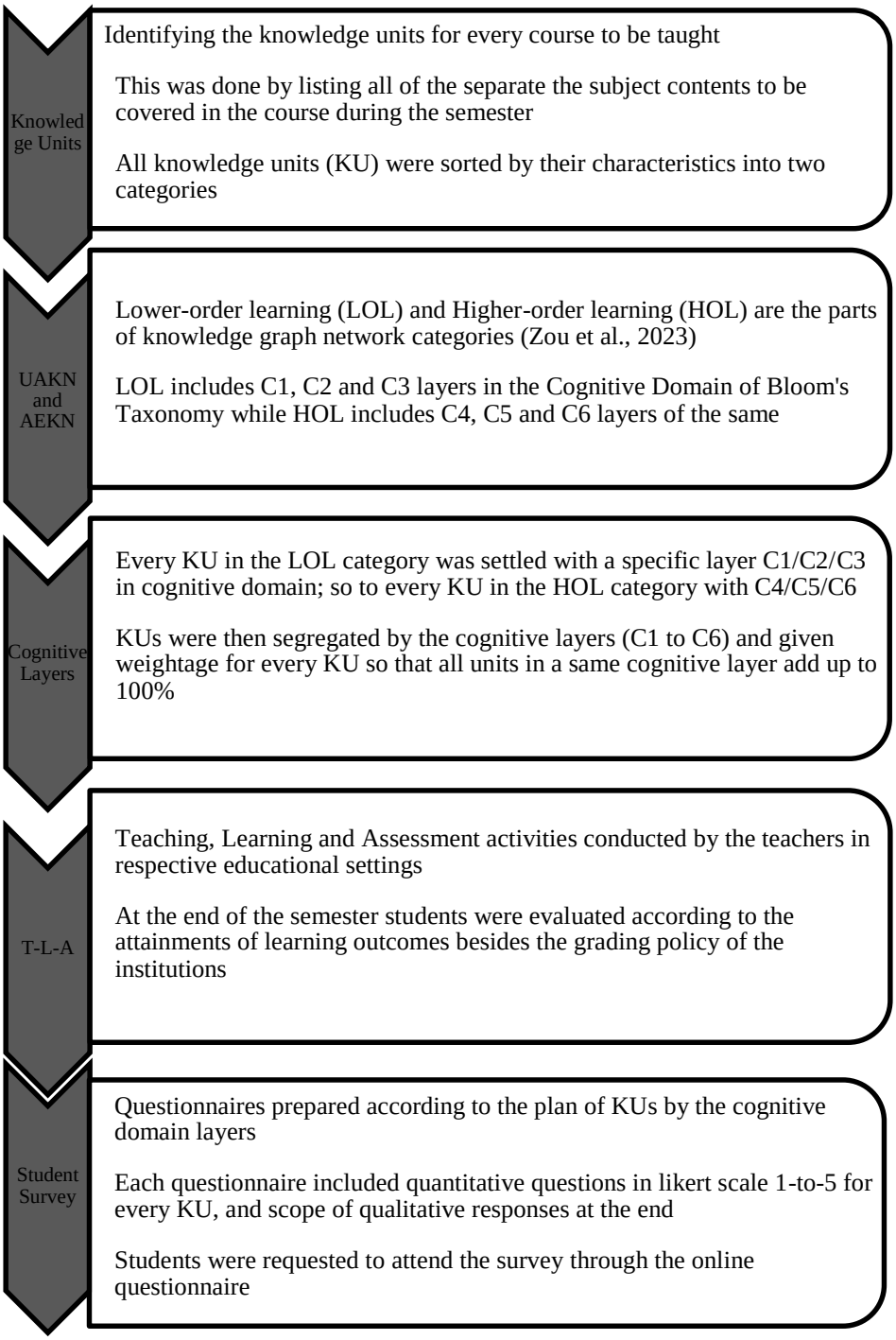

Figure 1: Conceptual Framework of the Research Methodology

(This diagram has been developed by the authors according to the flow of actions.)

Students went through various teaching, learning and assessment activities like attending class-lectures and different exams. Bangladeshi students attended the "MAT 000: Discrete Mathematics" and "ECO 000: Principles of Microeconomics" courses while the Thai students attended "ENT 000: Economics and Entrepreneurship", "MKT 000: Marketing Management" and "NUR 000: Adult Nursing II" courses. All these courses were compulsory for the respective programs at the undergraduate level. Course codes are deliberately mentioned as '000' to preserve the rights of unanimity of the concerned institutions.

Hence, the null hypothesis of this study was formed as stated below:

Ho(1) = There is no difference between the students' LOL and HOL by every subject selected in this study.

Ho(2) = There is no significant influence of students' LOL into achieving HOL.

Ho(3) = There is no difference between the students' LOL and HOL across all subjects by their age ranges.

Selected Courses

The courses were selected as these were taught by the research teachers in various disciplines for the students of five educational institutions in Bangladesh and Thailand. A brief description of each of the selected courses is given in Table 1.

Table 1: Descriptions of the Selected Courses Taught in Various Programs

Course	Brief Description
MAT 000	This course is offered for students enrolled in Bachelor of Computer Science and Engineering (BCSE) program. The main objective of this course is to help the students think logically for preparing algorithms, writing computer programs, designing a computer network or a database, analyzing graphics or audio, etc.
ENT 000	In the Economics and Entrepreneurship course, students will acquire the necessary knowledge and skills to organize and engage in entrepreneurial activities, together with knowledge of world economics. They will develop business analysis skills, gain an understanding of various business situations and trends in which entrepreneurs act, and practice planning and creating entrepreneurial activities.
MKT 000	This course highlights the role of marketing management from a business professional's perspective. It covers the processes involved in analyzing marketing opportunities and the development, implementation, evaluation, and control of marketing strategies.

Course	Brief Description
NUR 000	Complex health issues in adults about oxygen variation, gynecology nursing, oncology nursing, emergency nursing, trauma and disaster nursing, nursing care in the operating room, tools and medical technology, resurrection on acute phase, chronic and lasting crisis, by holistic nursing process, rational drugs use, palliative care, support the participation of individuals and families, based on cultural diversity awareness, moral ethics and patient rights.
ECO 000	The microeconomics course is designed to introduce the fundamental logic and reasoning of economics to enhance the analytical ability of the students to correctly perceive and interpret the behavior of an economy. The ability to understand market dynamics and processes for making choices are taught to the students by analyzing real-world applications.

3.2 Instrument, Sampling and Data

The questionnaire format for all the courses was finalized through consultation among the authors. Then, the structure of the Google Form was prepared, according to each course that was planned earlier, as the survey instrument by the individual subject teacher. A generic structure of the Google Form was developed and passed with an ethical review.

The sampling method was a non-probabilistic purposive technique. Each of four teachers, also the co-authors of this article, prepared a specific questionnaire based on the respective courses taught. Questions were made based on the respective course contents so that the responses reflect the learning of the subject matters by the students. All the concerned groups of students were asked to attend the online survey at the end of their semesters as a voluntary activity.

Surveys were conducted at different times throughout the period from February 2024 to March 2025. A total of 340 students responded in all 5 courses taught in the two selected countries. Table 2 shows the demographic data representation of respondents.

Table 2: Demographic Representation of the Respondents in Bangladesh and Thailand

Country	Course Code	Gender			Age Group			Total
		Male	Female	Not told	Below 21	22-26	27 or +	
Bangladesh	MAT 000	54	34	0	32	55	1	88
	ECO 000	85	48	0	27	105	1	133
Thailand	ENT 000	27	13	0	38	2	0	40
	MKT 000	10	5	0	0	6	9	15
	NUR 000	11	50	3	45	19	0	64
	Total	187	150	3	142	187	11	340

4. Results

The set of demographic information is presented by percentage of the respondents in Figure 2 categorized by (a) Course, (b) Gender and (3) Age-range.

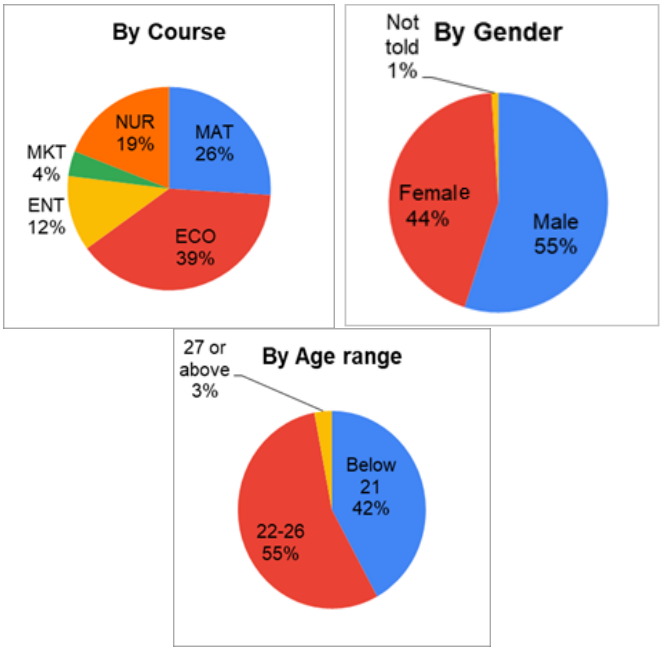

Figure 2: Demographic Information of the Respondents

Quantitative responses were organized to analyze the dataset. HOL and LOL scores were calculated as the latent variables from the quantitative responses to the corresponding questions. Some commonly used descriptive and inferential

statistical tools were used for analyzing the data. The level of significance was 95% for all analyses. The t-tests were done pair-wise and one-tailed. Tables 3 to 5 show the findings of the statistical analyses for all response data, and are also categorized by course and age range, respectively.

Table 3: Mean, Variance, Correlation and t-Test Values of the Data of All Students

All students' Learning	Mean	Variance	Std. Error	Correlation between LOL and HOL	Pair-wise 1-tailed t-test
LOL	4.03	0.5238	0.0393	0.900	0.290
HOL	4.04	0.5701	0.0409		

The standard error for the data of all students is negligible, as shown in Table 3, with a little variance of the mean for both lower-order and higher-order learning. Both of the learning categories – LOL and HOL – are strongly and positively correlated while the pair-wise t-test shows a not significant variation.

Table 4: Mean, Variance, Correlation and t-Test Values of the Students by Course

Students' Learning by courses	Mean	Variance	Std. Error	Correlation between LOL and HOL	Pair-wise 1-tailed t-test
LOL (MAT 000)	4.07	0.7403	0.0853	0.8922	0.0970
HOL (MAT 000)	4.02	0.6792	0.0879		
LOL (ECO 000)	4.33	0.3751	0.0531	0.8836	0.2541
HOL (ECO 000)	4.31	0.4632	0.0590		
LOL (ENT 000)	3.80	0.6117	0.1123	0.8817	0.0380*
HOL (ENT 000)	3.90	0.5560	0.1179		
LOL (MKT 000)	3.49	0.8664	0.2338	0.9434	0.3030
HOL (MKT 000)	3.44	0.9203	0.2477		
LOL (NUR 000)	3.60	0.2202	0.0587	0.8641	0.0002*
HOL (NUR 000)	3.72	0.2645	0.0643		

(* Significant, as the values showed are less than 0.05)

In the Standard errors negligible with reasonable variances in the learning results of LOL and HOL are shown in Table 4. Correlation coefficients are strong and positive in all cases of the subjects taught. Pair-wise 1-tailed t-tests are not significant in MAT 000, ECO 000 and MKT 000 while the other two show significance in variations in two means.

Table 5: Mean, Variance, Correlation and t-Test Values of the Students by Age Range

Students' Learning by Age range	Mean	Variance	Std. Error	Correlation between LOL and HOL	Pair-wise 1-tailed t-test
LOL (up to 21yr)	3.91	0.4464	0.0031	0.9015	0.0096*
HOL (up to 21yr)	3.97	0.4392	0.0031		
LOL (22 - 26yr)	4.15	0.5645	0.0030	0.8982	0.2404
HOL (22 - 26yr)	4.13	0.6570	0.0035		
LOL (27yr +)	3.63	0.3210	0.0292	0.9139	0.0472*
HOL (27yr +)	3.49	0.3616	0.0329		

(* Significant, as the values showed are less than 0.05)

Table 5 shows negligible standard errors for the data of all three age groups with all strong and positive correlation values. Pair-wise 1-tailed t-test is not significant for the student group of 22 to 26 years while the significant values are shown for the data of the other two age groups.

Finally, the comparison between the student's attainments of higher-order learning (HOL) and lower-order learning (LOL) is represented by the percentage of students in Figure 3.

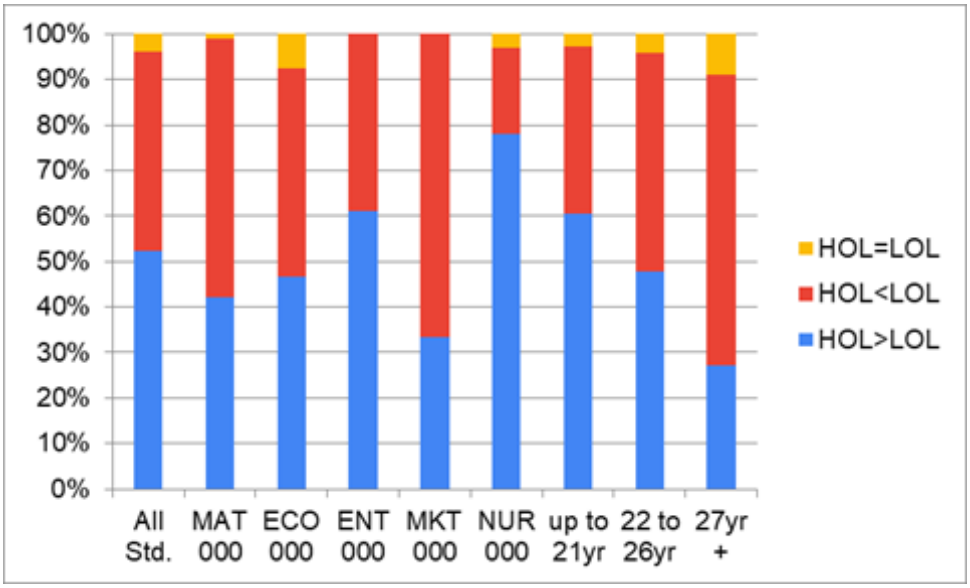

Figure 3: Students' Attainments Comparing HOL and LOL in Percentage

The first stack bar in Figure 3 represents the comparison among all students while the last three bars show the same by the age range. The remaining five stack bars in the middle show the comparisons among the students by their respective subjects.

5. Discussion

Pair-wise t-test values showed no significant variations in the two means of LOL and HOL in MAT 000, ECO 000 and MKT 000, while that was significantly different in ENT 000 and NUR 000. Hence, we failed to reject the null hypothesis *Ho(1)* for MAT 000, ECO 000 and MKT 000 while the same was rejected for ENT 000 and NUR 000.

Considering all students together, the correlation coefficient was 0.9 (Table 3). When the students were grouped by courses, the correlation coefficient was at least 0.86 (Table 4). This confirms the strong and positive dependency between HOL and LOL attainments. That means, higher-order learning is strong and positively depends on lower-order learning by the students. Here, we failed to reject the second null hypothesis *Ho(2)*. This result fully supports the previous findings of Shah and Zakaria (2024) and also by Sabir *et al.* (2024). Similarly, Hashim and Ahmed found in 2021 that lower-order thinking was essential to building the foundation of knowledge that helped make the higher-order thinking ability.

A few exceptions in the t-test results were found with slight variations in categories by age range. From the age-range findings, it can be summarized that the patterns of HOL and LOL entries are slightly varied for students of "up to 21yr" and "27yr +" groups. As a result, we reject the null hypothesis *Ho(3)* for the first and

third age groups. This confirms that the learning pattern of the middle-aged group is similar.

Higher-order learning (HOL) was attained by more students than lower-order learning (LOL) by all students. That ensures a comparatively better emphasis was successful for Analyzing, Evaluating and Creating in the process of teaching and learning over the foundations of Remembering, Understanding and Applying layers in the Cognitive domain. This coincides with the previous findings suggesting that higher-order learning helps develop problem-solving skills from real life (Stringer *et al.*, 2021). Agarwal (2019) stated in different words that higher-order learning enhances long-term retention of learning to face the realities. Students' attainments of learning grouped by their respective courses show more HOL attainments than those of LOL in "ENT 000" and "NUR 000". The opposite realities are found in "MAT 000" and "MKT 000". This observation coincides with the expected learning from theoretical and practical-oriented courses. Theoretical courses focus more on the understanding and application of the knowledge, to attain LOL. With the attainments in "MAT 000", LOL surpassed HOL by 12.8% of the students, while 32.6% of the students surpassed the same in "MKT 000". On the contrary, nursing education requires critical thinking, clinical reasoning, and decision-making competencies in real-life practices (Benner, 2024) that come from HOL. Moreover, business entrepreneurship ability needs strategic thinking, financial analysis, and managerial decision-making skills to be competitive in real business environments (Robinson & Brown, 2023). With the attainments in "ENT 000", HOL surpassed LOL by 22.0% of the students while 59.4% of the students surpassed the same in "NUR 000". Lastly, the findings from the Economics course were a mixture of both theoretical and practical-oriented subjects by their innate nature. Attainments by the students in 'ECO 000' are almost the same: higher HOL by 46.62% and higher LOL by 45.86% of students while 7.52% of students attained at the same level in higher and lower orders of learning.

Interestingly, it has been observed that students in the lower age range are more inclined to achieve higher-order learning (HOL) than lower-order learning (LOL). This contradicts a general hypothesis that comparatively aged learners are more capable of or willing to analyses real-life problems and eventually find a creative solution critically. However, a similar finding came from research on teacher training regarding higher-order thinking skills (HOTS) achievements (Hardiansyah, 2024). The researcher stated in the discussions on research findings that the results of the study indicated that teachers with short teaching experience could also implement HOTS, as well as experienced teachers. More rigorous research can be conducted on this particular issue.

6. Conclusions

It has been reassured that higher-order learning, consisting of Analyzing, evaluating, and creating in the Cognitive Domain, is more appreciable when students are expected to apply their knowledge to solve real-life problems. Such subject areas chosen in this research are business entrepreneurship and nursing. On the other hand,

lower-order learning, consisting of Memorizing, Understanding and Applying in the Cognitive Domain, is sufficient for the undergraduate level of education when the students are supposed to learn the theories and apply the knowledge to solve pre-structured problems in the field. Such subject areas chosen in this research are Mathematics and Marketing. In support of the previous conclusion, the findings from Economics show a balanced mixture of lower-order and higher-order learning. Lastly, an interesting finding suggests that older learners, by age, are more inclined to lower-order learning, which warrants further research initiatives.

Limitations: A generic instrument for collecting data from students of various subjects, time frames, education levels and societies was challenging. Homogeneity in the respondents' parameters would produce more reliable data to infer a better yield of findings. This diversity is not a straightforward limitation, but rather a potential advantage as well. Students' responses were supposed to be collected at the end of the academic terms: semester and trimester. Country-wide data were collected over an extended period, as the academic calendars of the institutions vary.

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Conflict of interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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