Student Learning Styles in Information Technology

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Abstract:- Teachers employ various strategies to facilitate student learning. Each student possesses a unique way of gaining motivation and absorbing information. Achieving the best possible outcomes in the teaching-learning process involves considering the individual learning styles of each student. Among the several models available for determining learning styles, Kolb's model stands out as widely utilized. This article aims to apply Kolb's learning styles model to identify the preferred learning styles of 53 students enrolled in a course focused on information technologies. The sampling method used was non-probabilistic, and data collection relied on the Kolb learning style inventory. The obtained results indicate that the prevailing learning styles among the surveyed students are convergent (47.2%) and assimilative (34.0%). Familiarity with the diverse learning styles of the students can significantly assist teachers in enhancing the efficiency of the teaching-learning process.

Key-Words: - learning, Kolb's model, education, learning styles

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1 Introduction

Each student possesses a distinct learning style and a unique manner of interacting with the world. The student's learning approach is rooted in cognitive and psychological factors. The various methods by which individuals acquire knowledge have been labeled as learning styles, [1]. Diverse learning styles have captured the attention of educators and the scholarly community, [2], [3]. Recognizing a student's predominant learning style can effectively enhance the learning process, [2], facilitating improved comprehension and retention.

Numerous authors concur that embracing the concept of learning styles allows for the implementation of suitable pedagogical methodologies within the classroom, [4]. It also enables the cultivation of a versatile approach that resonates with the majority of students, [5]. Consequently, the notion of learning styles serves as a tool for refining the teaching-learning process.

Learning entails the acquisition or adaptation of ideas, skills, capabilities, behaviors, or principles. As per Kolb, learning leads to the assimilation of abstract concepts applicable across diverse scenarios. However, when presented with the same information, distinct individuals may interpret, process, and grasp it in varying ways. The interest in learning styles has given rise to the formulation of several learning style models, including Felder's model, Kolb's model, [6], and the VARK model, denoting visual, auditory, reading/writing, and kinesthetic processes that emphasize, [7].

Kolb's model "is based on experiential learning theory", [6]. Kolb introduced a questionnaire consisting of 12 questions designed to assess learning styles. This inventory enjoys widespread acceptance and use, [8]. In his proposition, Kolb, [6], stipulated that four processes are requisite for effective learning: "(1) concrete experience (CE), (2) reflective observation (RO), (3) abstract conceptualization (AC), and (4) active experimentation (AE)."

Felder's model establishes four interconnected dimensions: "active-reflective (processing information); sensing-intuitive (perceiving information); visual-verbal (inputting information) and sequential-global (understanding information)", [7]. The VARK model underscores the previously mentioned visual, auditory, reading/writing, and kinesthetic classifications.

Kolb's model has found utility in discerning students' learning styles. This investigation employs Kolb's model to ascertain the learning preferences of undergraduate students pursuing information technology-related courses. Such courses encompass subjects like mathematics, programming, and model conceptualization, among others. The capacity to recognize and tackle challenges through innovative means holds paramount significance. Various studies probing student attrition in information and communication technology courses

suggest that individuals encountering difficulties in mathematics and programming may be prone to discontinuation, especially during the initial years of study.

This work aims to determine the predominant learning styles among university students enrolled in information technology-related courses.

This study adds to the existing body of knowledge concerning learning styles among students in the realm of information technology, offering valuable insights for educators, administrators, and students alike. Comprehending student learning styles equips teachers with the tools to employ varied strategies within the teaching-learning process, thereby enhancing the effectiveness of student learning.

2 Kolb's Model and Learning Styles

Learning theories elucidate how people acquire, retain, and recall knowledge. A learning style represents the preferred manner in which a student processes and retains information. Table 1 presents the description of learning styles, adapted from Kolb, [6].

Table 1. Learning styles

Learning style	**Description**
Divergent	Divergent learners live in the present with enthusiasm and a preference for short-term planning. They are good team players and become involved in the activities of others. Creative and open-minded, they generate ideas.
Assimilative	Assimilative learners are characterized by analytical behavior. They observe and analyze experiences, collecting data and examining them to draw conclusions. They act cautiously, are not very sociable, and prefer to go unnoticed. Preferring to listen rather than talk, they are observant, patient, and detail-oriented.
Convergent	Convergent learners place a high value on logic and reason and are uncomfortable with an absence of logic. They seek objectivity and shy away from the subjective.
Accommodative	Accommodative learners put into practice the knowledge, techniques, and theories they have learned. They are practical and realistic.

2.1 The Kolb Model

According to Kolb, "learning is the process whereby knowledge is created through the transformation of experience", [6]. Kolb identified four learning styles: convergent (problem-solving and implementation of ideas), divergent (imaginative ability), assimilative (strong inductive reasoning), and accommodative (efficiency in executing plans), [9]. Kolb's learning cycle encompasses four action stages: feeling, observing, thinking, and doing.

Furthermore, Kolb's model serves as an appropriate pedagogical framework for engineering education, [10], with individuals possessing a divergent learning style often opting for careers such as computer science or engineering, [11].

Researchers have shown keen interest in the learning styles of students across various disciplines. To comprehend the extent of this interest, this study examined articles published in the Scopus database.

To identify relevant scientific in computer science and engineering, the following search string was utilized: *(TITLE-ABS-KEY (Kolb OR Kolb's) AND TITLE-ABS-KEY (students) AND TITLE-ABS-KEY (engineering and "computer science"))*. This search included journals and conference papers. Figure 1 illustrates the publications found in Scopus from 1982 to 2022.

Figure 1 indicates an upward trajectory in publications related to Kolb's model across different disciplines (total). The most significant surge is observed in the period from 2017 to 2020, which partially coincides with the onset of the COVID-19 pandemic. The pandemic led to university closures and necessitated the transition from in-person classes to virtual ones.

The trend of publications related to Kolb's model in computer science and engineering also exhibits a slight rise until 2019. Among the countries contributing most to these publications are the United States (388), the United Kingdom (99), Australia (67), Turkey (60), and Canada (54).

Figure 2 displays the distribution of articles published on Kolb's model by subject area. Notably, 12.4% of articles fall under the engineering field, while 11.0% pertain to computer science.

An analysis of keywords utilized by authors in the selected Scopus listings was performed using the VOSviewer software, [12]. This analysis revealed six clusters, as presented in Table 2.

The first cluster pertains to the intersection of Kolb's learning styles and technologies, encompassing intelligent tutoring, and online learning. personalized learning and problem-solving.

Cluster 2 is linked to appropriate technology, cognitive systems, and machine learning techniques, among other subjects.

Cluster 3 is associated with mathematical models, project management, education, and curricula.

Cluster 4 includes keywords related to learning, experiential learning, learning styles, and online systems.

Cluster 5 addresses individual differences, personalization, learning systems, and student learning styles.

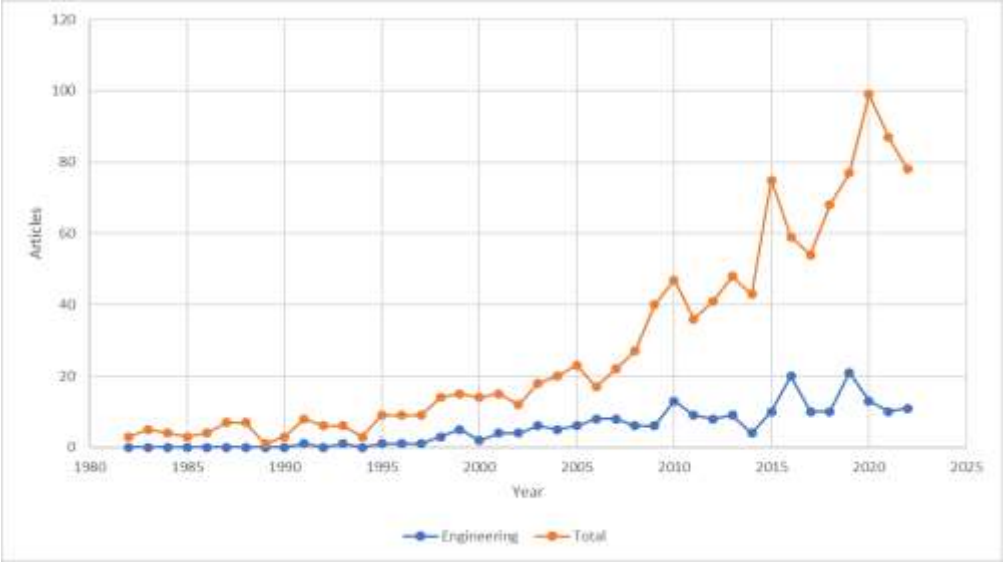

Fig. 1: Publications concerning the Kolb model per year in Scopus: total vs. engineering publications

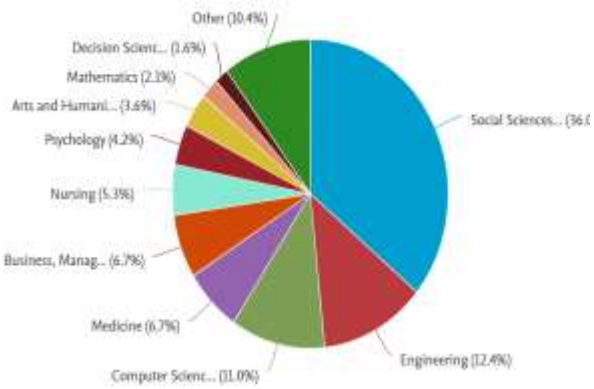

Fig. 2: Articles on Kolb's model in Scopus by area

Cluster 6 includes topics such as computer science, mechanical engineering, and Kolb's learning style inventory.

Table 2. Keywords used in Scopus publications on Kolb's model

Cluster	Keywords
1	Communication, computer-aided instruction, e-learning, education computing, education field, individual learning, intelligent tutoring system, Kolb's learning style, online learning, personalized learning, and problem-solving.
2	Appropriate technology, behavioral research, brain signals, electroencephalogram (EEG), classification (of information), cognitive systems, electroencephalography, and personality type.
3	Curricula, engineering education, learning strategy, mathematical models, personnel training, professional aspects, project management, students, and teaching.
4	Experiential learning, learning, learning effectiveness, learning styles, online systems, and World Wide Web.
5	Individual differences, learning systems, personalization, student learning style.
6	Computer science, Kolb's learning style inventory, mechanical engineering, multimedia systems.

2.2 Applications of Kolb's Model

Kolb's model has been utilized to ascertain the learning styles of students across various subject areas and to design educational programs. The study, [13], contends that when planning a medical program, considering student learning styles is crucial, a determination that can be facilitated through the employment of the Kolb inventory.

Kolb's inventory has proven effective in designing adult-oriented education programs, [14], and in elucidating the distinctions between the learning styles of surgical residents and general surgeons, [15].

The study, [16], evaluated disparities in learning styles, leadership skills, and critical thinking abilities. The presence of students with diverse learning styles presents an opportunity within the teaching-learning process, rather than a hindrance, [3].

In fields like computer science, the motivation to apply Kolb's model in discerning students' learning styles arises from the necessity to bolster their metacognition. Metacognition, a vital aspect of mastering programming, involves the "observation and control of one's discernment exercises", [17].

The study, [18], employed Kolb's model and machine learning to categorize 546 students based on their attributes using clustering techniques.

The learning cycle encompassing four processes as presented in Kolb's model has been harnessed to formulate course modules in complex system design, develop educational packages, and compare student attitudes. For instance, it was employed as an organizational principle in a study where undergraduate students in electronic and computer engineering learned about hardware security threats and the development of a secure chip design module, [19].

An educational package founded on a serious game was devised for disaster prevention education, [20]. While conventional educational methods often fail to convey past experiences or stimulate student interest, games prove highly effective in disaster management. Consequently, the study, [20], incorporated Kolb's experiential learning cycle into their "Battle of Flooding Protection" game, leading to significant positive outcomes in students' disaster prevention skills.

Kolb's model has also been synergistically employed with other methodologies to enhance the learning environment and thereby amplify students' capabilities by fostering experiential learning, [21].

In a bid to ameliorate the competencies and academic performance of mechanical engineering students, Kolb's model was implemented to identify learning styles and appropriate learning models in one instance; this yielded a favorable impact on academic performance, [22].

Moreover, numerous studies have posited that in the domain of Technology Enhanced Learning, the consideration of students' learning styles is imperative when devising educational sequences, as suitable adaptation could heighten their motivation, [23].

Pedagogical approaches rooted in Kolb's model have been incorporated into automotive engineering courses, focusing on the dynamic performance of vehicles and providing a learning environment enriched with hands-on experiments, [24].

In the realm of health, Kolb's model has been harnessed within the teaching-learning process for biomedical engineering students who observed a medical care procedure. They identified an issue and proposed an enhancement that was implemented, yielding benefits for both students and professors, [25].

In the field of automotive engineering, Kolb's model has been applied to enhance the learning experiences of engineering students, encompassing subjects like sensors, actuators, interfacing, and programming for industrial and automotive automation applications, [26]. Also, Kolb's model has been used in a course on software engineering focus on modeling to developing software systems (Unified Modelling Language), [27]; the results show that the predominant learning styles were convergent (27%), assimilative (27%) and accommodative (23%).

Additionally, machine learning, [18], data mining, or process mining techniques are widely used to improve organizational performance, decision-making, and organizations more competitive, [28], and are usually offered in areas such as Computer Science and Engineering. Kolb's model has been applied to determine the connections between learning styles and specific performance outcomes of 86 undergraduate students not majoring in computer science, [29]. The results indicate that the predominant learning styles were accommodative (43%), convergent (33%), and assimilative (13%).

3 Methodology

A cross-sectional descriptive study was undertaken, involving 53 undergraduate students from an engineering school who were enrolled in information technology-related courses. The sampling method employed was non-probabilistic.

For data collection, the researchers utilized Kolb's inventory, [6], which was adapted to include items such as age, gender, course, type of high school (state or private), and place of origin. An online questionnaire was employed for data collection. The responses from the surveys were organized within an Excel spreadsheet. Subsequent calculations were carried out to ascertain learning styles in accordance with Kolb, [6], followed by data analysis employing SPSS software.

The participants encompassed both genders, with 84.9% being male and 15.1% being female. In terms of educational background, 62.3% attended private high schools, while 37.7% attended public high schools.

4 Results

The research results indicate the characteristics of the surveyed students. It is discernible that all learning styles are present among the participants in the study. Notably, the prevailing learning styles observed among these students were the convergent learning style (25) and the assimilative learning style (18). Conversely, fewer students were exhibiting an accommodative learning style (4) or a divergent learning style (6).

Table 3 shows the percentage distribution of study participants based on their learning styles. Students predominantly inclined towards a convergent learning style tend to possess rational, analytical, and task-oriented characteristics. They take pleasure in technical facets, employ deductive reasoning, and often excel in the practical application of ideas. Sequential thinking is a hallmark of their cognitive approach. They might experience discomfort with endeavors lacking logical structure or subjective judgments. The outcomes underscore that 47.2% of the surveyed undergraduate students identified with the convergent learning style.

According to Kolb, individuals exhibiting an assimilative learning style emphasize AC and RO. They possess a strong inclination towards ideas and concepts, often aspiring to formulate models and appreciate coherence. The outcomes reveal that 34.0% of the surveyed students aligned with an assimilative learning style.

Table 3: Percentage of study participants by learning style

Learning style	Quantity	%
Accommodative	4	7.5
Assimilative	18	34.0
Convergent	25	47.2
Divergent	6	11.3

On the other hand, students manifesting a divergent learning style typically demonstrate creativity, adeptness in generating diverse problem-solving approaches, and a penchant for imaginative, emotional, and empathetic thinking. Their cognitive approach leans towards inductive or deductive reasoning. According to the findings, 11.3% of the surveyed students identified with a divergent learning style.

Learners characterized by an accommodative learning style exhibit adaptability to various circumstances and a willingness to take risks. They often rely on instinct or intuition rather than logical analysis. The results indicate that 7.5% of the surveyed students displayed an accommodative learning style.

5 Discussion

The findings of this study highlight the utility of the Kolb inventory in delineating the learning styles of university students pursuing careers associated with information technology. Kolb's model can also provide insights into comprehending information and communication technologies, [21]. The significance of discerning students' learning styles arises from the imperative to understand their attributes and enhance teaching strategies for more impactful learning experiences.

The outcomes align with prior studies conducted among engineering students, wherein assimilative and convergent learning styles prevailed, particularly the convergent style among Informatics Engineering students, [4], or Software Engineering students, [27]. The dominant learning style identified in this study correlates with the competencies demanded of engineering students, namely problem-solving. In the realm of computer science, programming and analytical skills are prerequisites for effectively applying techniques, methodologies, and tools to resolve specific challenges.

According to, [11], individuals possessing a convergent learning style exhibit characteristics of adept problem-solving and decision-making. Such individuals often gravitate towards professions

demanding technological acumen, such as engineering or computer science. To enhance their abilities, they could focus on refining aspects linked to decision-making and goal establishment.

Students demonstrating an assimilative learning style exhibit an affinity for technical tasks and the generation of models. To address the deficiency in practical implications, improvements should be targeted at aspects related to experimental design and quantitative data analysis.

The results of this study show that students have diverse learning styles. In, [29], the predominant learning styles of students not majoring in Computer Science were accommodative and convergent. According to, [5], a common concept says that individuals differ in how they learn.

Educators should acquaint themselves with their students' learning styles to tailor suitable pedagogical strategies. Similarly, students, armed with knowledge of their learning styles, can identify their strengths and address their weaknesses.

In fields tied to information technologies, students should engage in projects aimed at solving authentic problems, thus preparing themselves to confront challenges posed by the digital transformation of organizations.

A limitation of this study rests in its inability to generalize results due to the participant count and the nature of the sample. In forthcoming research, students from information technology-related fields across a representative selection of universities should be considered to enhance the study's robustness.

6 Conclusions

The topic of learning styles within courses linked to information and communication technologies garners significant interest within the academic community. This study delved into the learning styles of 53 undergraduate students, utilizing Kolb's inventory as a data collection instrument. The findings showcased a prevalent presence of both the convergent learning style, evident in 47.2% of the sample, and the assimilative style, accounting for 34.0%. Consequently, educators should tailor their pedagogical approaches primarily to align with these predominant learning styles. It is important to note that a limitation of this study lies in its sample size. The outcomes of this study are anticipated to be valuable to students, academic administrators, and most importantly, educators. Acquiring an understanding of their students' learning styles empowers teachers to implement instructional strategies more likely to resonate with the majority of students. In subsequent research endeavors, evaluating learning styles across diverse courses can help establish distinct student profiles.

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