



## Original Article

## Exploring the Relationship Between Educational Theories and Occupational Therapy Studies: A Correlation Analysis of Kolb's Learning Steps, Learning Styles, and Dunn's Sensory Processing Patterns Among Iranian Occupational Therapy Students

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## ABSTRACT

**Background:** Learning encompasses lasting alterations in behavior stemming from experience. The sensory system receives and interprets information gathered from individual experiences, priming it for integration with other neuro-psychological facets of learning. The processes and modalities of learning, juxtaposed with sensory processing, may or may not exhibit interrelation akin to gears within a learning clock mechanism. The objective is to explore the potential correlation between the stages and styles of learning outlined by Kolb and the sensory processing patterns delineated in Dunn's model.

**Methods:** This correlational study involved undergraduate Occupational Therapy students from the Rehabilitation Faculty at Shiraz University of Medical Sciences (SUMS) in Iran. In 2018, all students were invited to participate and were asked to complete two questionnaires: The Kolb Learning Styles Inventory and the Adolescent/Adult Sensory Profile. Out of 83 distributed questionnaires, responses from 62 participants were included in the analysis. The collected data underwent descriptive and analytical statistical analyses using SPSS23 software.

**Results:** Findings revealed no significant correlation between Kolb's Learning Steps and Learning Styles and Dunn's Sensory Processing Patterns among Iranian Occupational Therapy students ( $P > 0.05$ ). However, there was a correlation between low registration and preferred learning steps among female students ( $P = 0.003$ ).

**Conclusion** The findings suggest no correlation between learning steps and learning styles with sensory processing patterns overall. However, gender-based analysis indicates a potential correlation among participants exhibiting low registration sensory patterns.

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## Introduction

Learning is a relatively stable behavioral change based on individuals' experiences, beginning from early developmental stages [1] and continuing throughout life [2]. Within the Theory of Experiential Learning, Kolb emphasizes that experience is fundamental in knowledge

development, suggesting that learning occurs through active engagement and exploration [3]. Kolb's experiential learning theory outlines different steps of learning, including concrete experience (engagement in activities or tasks), reflective observation (stepping back to reflect on the task), abstract conceptualization (drawing conclusions from experience based on previous knowledge or discussing theories with peers), and active experimentation (applying conclusions to new experiences). While these steps work together to create an educational experience,

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individuals may prefer certain aspects over others. For instance, some may rely heavily on concrete and reflective experiences, whereas others may allocate less time to the active and abstract steps [3, 4].

Additionally, Kolb identified four different learning styles in his theory, namely diverging (concrete experience/reflective observation), assimilation (abstract conceptualization/reflective observation), converging (abstract conceptualization/active experimentation), and accommodating (concrete experience/active experimentation) [5]. Learning styles are viewed from various perspectives, including models of personality traits, information processing, social interaction, and instructional preference [6]. Furthermore, the learning process varies across different contexts, and learners do not all learn at the same rate or in the same manner. Individuals may respond differently in identical situations, influenced by their distinct learning styles. People adopt various learning styles based on their differences [7].

Based on the term “experience” in the defined learning process, knowledge acquisition relies on our sensory system to absorb information from the surrounding environment. The sensory system receives and processes this information, preparing it for other neuropsychological aspects of learning systems [8] while influencing mood, emotions, and personal interests [9-14]. Research indicates that sensory processing may be the fundamental psychological element underlying perception and response to environmental stimuli [15]. As individuals’ sensory processing patterns can influence their behavior in life [16], they are likely also to impact how they learn from their experiences, particularly in academic settings. This aspect warrants further exploration through related studies [17]. Recognizing the significance of this matter, Dunn highlighted that human beings live sensorially [16].

Dunn’s sensory processing model explores how individuals perceive, regulate, interpret, and respond to sensory stimuli daily. Dunn developed the Four Quadrant Model of Sensory Processing, which posits a relationship between neurological thresholds and behavioral responses. A low neurological threshold indicates that an individual readily attends to and responds to stimuli. In contrast, a high neurological threshold suggests a need for more intense stimuli to elicit a response. When individuals attempt to self-regulate in response to a sensory experience, they may employ active or passive behavioral strategies. Within this model, there are four sensory processing patterns: sensory seeking (high neurological threshold, active responses), low registration (high neurological threshold, passive responses), sensory avoiding (low neurological threshold, active responses), and sensory sensitivity (low neurological threshold, passive responses).

A fundamental tenet of Dunn’s Four Quadrant Model of Sensory Processing is that an appropriate balance between habituation and sensitization is necessary for effective sensory modulation and adaptive behavioral responses. For instance, individuals with sensory sensitivity often exhibit heightened focus on sensory experiences from their bodies and surroundings, leading to a sustained

state of hyper arousal, hypervigilance, and emotional dysregulation. An individual may be described as sensory defensive when their nervous system is rapidly triggered, perceiving sensory stimuli as threatening or harmful, eliciting fight-or-flight responses in the sympathetic nervous system [18].

While most individuals experience a typical range of sensory processing, there may be variations, particularly in sensory sensitivity, even within a normal population [19]. Furthermore, learning styles (LS), preferences for learning, and sensory processing (SP) are akin to gears in the learning mechanism, potentially interconnected but not necessarily so. Several studies have explored the relationship between Kolb’s learning styles and Gardner’s Multiple Intelligence Theory [20, 21], as well as preferred learning styles among undergraduate students [22] and nursing students’ Kolb learning styles and problem-solving skills [23]. While these studies suggest potential correlations between learning styles and other factors, such as intelligence and problem-solving skills, they do not specifically address the relationship between sensory processing and Kolb-based learning styles. Thus, it remains unclear whether there is a direct relationship between sensory processing and Kolb-based learning styles based on the existing research literature.

Moreover, Occupational Therapy bachelor students undergo various theoretical, practical, and clinical courses, engaging in various activities and tasks throughout their 4-year education. The objective of the current study was to explore the potential correlation between Kolb’s Learning Steps and Learning Styles with Dunn’s Sensory Processing Patterns. The authors conducted a correlational study involving Occupational Therapy students at Shiraz University of Medical Sciences (SUMS)

Based on the important issues outlined, the main questions addressed in this study were as follows:

1. What were the predominant sensory processing patterns among Occupational Therapy students?
2. Which learning steps were more and less prevalent among Occupational Therapy students?
3. What were the preferred learning styles among Occupational Therapy students?
4. Is there a correlation between learning styles and sensory processing patterns among Occupational Therapy students?
5. Is there a correlation between learning steps and sensory processing patterns among Occupational Therapy students?

## **Methods**

This descriptive correlational study was conducted at Shiraz University of Medical Sciences in Iran in 2018. The study employed a census sampling method, which included all undergraduate Occupational Therapy students from the School of Rehabilitation Sciences at SUMS who were enrolled in 2018 and agreed to participate by completing an informed consent form. Incomplete questionnaires were excluded from the analysis. After obtaining participants’ approval, printed

questionnaires were administered in face-to-face sessions at a quiet location within the rehabilitation faculty to ensure maximum concentration. Notably, participation in the study was voluntary for all students in the Occupational Therapy department. Each participant completed two questionnaires: first, the Kolb Learning Styles Inventory (KLSI-V3.1-2005), which was validated and deemed reliable by Ghasemi et al., consisting of 12 questions based on a forced Likert scale (totally matched, partly matched, matched a little, doesn't match) [24]. According to Kolb's theory, this questionnaire assessed four learning styles: Diverging, Assimilating, Converging, and Accommodating. The questionnaire also evaluated four learning steps: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation.

Secondly, the Adolescent/Adult Sensory Profile (AASP) is a widely used and validated self-report measure of sensory processing in Occupational Therapy literature. It is known for its robust psychometric properties. The AASP assesses an individual's sensory processing and behavioral responses based on the Four Quadrant Model of Sensory Processing [25]. This questionnaire comprises four scales that gauge sensory seeking, sensory avoidance, sensory sensitivity, and poor registration across various sensory dimensions, including auditory, visual, movement, tactile, smell, and activity levels. Responses are scored on a five-point Likert scale, ranging from "almost never" (score 1) to "almost always" (score 5), with intermediate options for varying frequencies. In cases where a subject marks two answers on the answer sheet, the more dominant response, garnering more points, is considered. Each sensory processing pattern encompasses 15 questions, with the total score for each pattern derived from the cumulative scores of its related questions. Thus, the minimum score for each sensory processing style is 15, while the maximum is 75 [15]. Zaree et al. conducted the translation, reliability, and validity assessment of the Persian version of the Adolescent/Adult Sensory Profile [26].

The descriptive analysis included reporting each variable's mean, standard deviation, and percentage. The authors employed a Pearson chi-square test to determine the correlation between each factor of learning steps and learning styles with sensory processing patterns. Statistical analysis was conducted using IBM SPSS Statistics for Windows version 23.0, and P values below 0.05 were considered statistically significant.

#### Ethical Approval

The SUMS Research and Ethical Committee approved the study protocol with registration code IR.SUMS.REC.1397.531. Before participating in the study, written consent was obtained from each participant. They were

assured of anonymity and guaranteed that their data would be used solely for research purposes, with no potential for it to be used either for or against them, and that no data manipulation would occur.

## Results

Out of the total number of filled questionnaires (83), 21 were excluded due to incomplete responses, resulting in 62 questionnaires included in the analysis. Among the participants, 48 were female (77.4%) and 14 were male (22.6%). The mean age of the participants was  $21 \pm 1.22$ . Regarding achievement scores, 12 participants (19.4%) received a score of A- up to A+ (17-20), 42 participants (67.7%) received a score of B- to B+ (14-16.99), and 8 participants (12.9%) received a score of C- to C+ (scores under 14). Furthermore, a statistically significant difference was observed between males and females in achievement scores, with females obtaining higher grades ( $P=0.03$ ).

According to the results of learning steps, five individuals (8.1%) fell into the category of "concrete experience or feeling", 7 (11.3%) were categorized as "reflective observation or watching", 28 (45.2%) were classified under "abstract conceptualization or thinking", and 22 individuals (35.5%) were grouped as "active experimentation or doing".

According to the investigation of "learning styles" in the Occupational Therapy students, four individuals (6.5%) were classified as "diverging or feel and watch". In comparison, 14 individuals (22.6%) fell into the "assimilation or think and watch" category. Moreover, 36 individuals (58.1%) were categorized as "converging or think and do", and eight individuals (12.9%) were grouped as "accommodating or feel and do".

Table 1 reveals the participants' sensory processing patterns according to Adolescent/Adult Sensory Profile (AASP). Table 2 presents the correlation results for the following pairs: 'Low Registration and Learning Steps', 'Sensory Seeking and Learning Steps', 'Sensory Sensitivity and Learning Steps', 'Sensory Avoiding and Learning Steps', 'Low Registration and Learning Styles', 'Sensory Seeking and Learning Styles', 'Sensory Sensitivity and Learning Styles', and 'Sensory Avoiding and Learning Styles'. Table 3 displays the correlation P value results, segmented by gender.

A separate correlation test assessed gender differences between male and female groups. The results revealed a non-significant correlation between three sensory processing patterns (sensory seeking, sensory sensitivity, and sensory avoiding) and learning styles and learning steps in both groups. However, a strong correlation between Learning Steps and Low Registration was observed in the female group ( $P=0.003$ ) (Table 3).

**Table 1:** Participants' sensory processing patterns according to Adolescent/Adult Sensory Profile (AASP)

Quadrants of Sensory Processing	Much less than most people	Less than most people	Similar to most people	More than most people	Much more than most people
Low Registration	0 [0%]	5 [8.1%]	33 [53.2%]	20 [32.3%]	4 [6.5%]
Sensory Seeking	1 [1.6%]	4 [6.5%]	49 [79%]	6 [9.7%]	2 [3.2%]
Sensory Sensitivity	0 [0%]	4 [6.5%]	37 [59.7%]	14 [22.6%]	7 [11.3%]
Sensory Avoiding	1 [1.6%]	4 [6.5%]	37 [59.7%]	14 [22.6%]	6 [9.7%]

**Table 2:** Correlation P value results of “Low Registration and Learning Steps”, “Sensory Seeking and Learning Steps”, “Sensory Sensitivity and Learning Steps”, “Sensory Avoiding and Learning Steps”, “Low Registration and Learning Styles”, “Sensory Seeking and Learning Styles”, “Sensory Sensitivity and Learning Styles”, “Sensory Avoiding and Learning Styles”

Variables' correlation	Correlation P value
Low Registration and Learning Steps	0.104
Sensory Seeking and Learning Steps	0.778
Sensory Sensitivity and Learning Steps	0.615
Sensory Avoiding and Learning Steps	0.687
Low Registration and Learning Styles	0.680
Sensory Seeking and Learning Styles	0.788
Sensory Sensitivity and Learning Styles	0.654
Sensory Avoiding and Learning Styles	0.964

**Table 3:** Correlation P value results according to gender

Variables correlation	Female	Male	Overall
Low Registration and Learning Styles	0.13	0.51	0.68
Low Registration and Learning Steps	0.003 *	0.75	0.1
Sensory Seeking and Learning Styles	0.85	0.43	0.78
Sensory Seeking and Learning Steps	0.82	0.4	0.77
Sensory Sensitivity and Learning Styles	0.92	0.32	0.65
Sensory Sensitivity and Learning Steps	0.46	0.34	0.61
Sensory Avoiding and Learning Styles	0.86	0.21	0.96
Sensory Avoiding and Learning Steps	0.73	0.22	0.68

## Discussion

The present study addressed various inquiries concerning learning steps, learning styles, and sensory processing patterns, along with their potential correlations among Occupational Therapy students enrolled at the School of Rehabilitation Sciences at SUMS in Iran.

The first question addressed in this study was: “What were the predominant sensory processing patterns among Occupational Therapy students?” The findings indicated that 53.2% of students fell within the normal range, while 46.8% exhibited patterns outside the normal range regarding low registration. Furthermore, 79% of participants demonstrated sensory seeking within the normal range, while 21% displayed patterns outside the normal range. Additionally, 59.7% performed similarly to most people regarding sensory sensitivity and sensory avoiding patterns, while 40.3% exhibited some deviation. Among all sensory processing dysfunctions, those related to the “more than most people” group were most prevalent. Greater student deviation appears to be associated with the ‘low registration’ pattern. In the sensory-seeking quadrant, their behavior largely mirrors the general population’s. In a study by Ben-Avi et al. (2012) involving 123 undergraduate students at Haifa University, 88 students (71.5%) were found to be within the normal range, while 35 individuals (28.5%) exhibited patterns outside the normal range in terms of sensory defensiveness.

Furthermore, 87 individuals (70.7%) fell within the normal range in the sensory avoidance quadrant, while 36 individuals (29.3%) were outside the normal range. Similarly, 95 individuals (77.2%) exhibited patterns within the normal range within the sensory-seeking quadrant, whereas 28 individuals (22.8%) were outside the normal range. In the low registration quadrant, 84 individuals (68.2%) were classified as normal, while 39 individuals (31.8%) displayed patterns

outside the normal range [12]. Mahmoudi et al. (2020) reported that among 184 students from various fields of rehabilitation sciences at Shahid Beheshti and Iran University of Medical Sciences, 46.7% of occupational therapy students exhibited sensory seeking problems, 27.38% experienced low registration problems, 33.5% encountered sensory sensitivity issues, and 32.43% faced sensory avoidance challenges [15].

The second question examined was: “Which learning steps were more and less prevalent among Occupational Therapy students?” The findings revealed that the preferred learning steps were as follows: “abstract conceptualization or thinking” (45.2%), “active experimentation or doing” (35.5%), “reflective observation or watching” (11.3%), and “concrete experience or feeling” (8.1%). There is a lack of direct research addressing the learning steps of occupational therapy students according to “Kolb’s experiential learning cycle” in the available literature.

A study explores using Kolb’s reflective learning cycle to support students’ capacity for clinical reasoning and better prepare them for clinical placement [27]. This study suggests that Kolb’s experiential learning cycle can support students’ learning and development, although it does not provide specific information about the learning steps of occupational therapy students. From this perspective, occupational therapy students who prefer the concrete experience stage may be more inclined towards hands-on learning and prefer to acquire knowledge through direct experience. Conversely, those who favor the reflective observation step may prefer reflective learning and tend to learn through observation and analysis. Similarly, students who lean towards the abstract conceptualization step may prefer theoretical learning, preferring to engage in conceptualization and analysis. Lastly, students who resonate with the active experimentation step may demonstrate a propensity for experimental learning and prefer learning through trial and error.

The third question investigated in this study was: “What were the preferred learning styles among Occupational Therapy students?” The findings revealed that OT students in Iran exhibited a preference for various learning styles, with “converging or think and do”, “assimilation or think and watch”, “accommodating or feel and do”, and “diverging or feel and watch” being the most favored styles in descending order.

Convergers, among OT students, emphasize problem-solving as a key learning approach. They demonstrate an ability to formulate and implement plans in novel situations promptly. Unlike Divergers, who tend to shy away from interpersonal interactions and observations, Convergers seek specialized solutions.

Assimilators, on the other hand, prioritize critical thinking. They excel in assessing facts and evaluating experiences holistically. Typically, they derive satisfaction from comprehensive analyses and seeing projects through from inception to completion [28].

Research by French et al. (2007) indicated that occupational therapy students exhibited preferences in learning styles, with ‘diverging’ at 30.2%, ‘converging’ at 28.4%, ‘assimilating’ at 22.4%, and ‘accommodating’ at 19.0% [6]. Similarly, Linares et al. (1999) observed that OT students could be categorized as “accommodators” or “convergers”. Both groups demonstrate a propensity for active experimentation within the learning process, exhibiting tendencies towards either end of the concrete-abstract spectrum.

As “accommodators,” students are inclined towards hands-on experiences and exhibit strengths in collaborative problem-solving. Conversely, “convergers” tend to favor abstract conceptualization, demonstrating proficiency in practical problem-solving tasks over social and interpersonal challenges [29].

Furthermore, Olivier et al. (2021) utilized the Grasha-Reichmann learning style inventory to evaluate the learning styles of OT and Physiotherapy (PT) students. They found a prevalent preference for the collaborative learning style among students (75%). Interestingly, male students exhibited higher scores in the competitive learning style than their female counterparts [30].

The fourth research question addressed in this study was: “Is there a correlation between learning styles and sensory processing patterns among Occupational Therapy students?” The study findings revealed no significant correlation between learning styles and sensory processing patterns in OT students.

Some previous studies offer insights into the potential relationship between learning styles and sensory processing patterns. For instance, a study explored the preferred learning styles among Diploma students of Occupational Therapy, revealing that the visual learning style was most favored, followed by active, sensing, reflective, and sequential styles [31]. In another investigation, two questionnaires were employed to explore the potential association between sensory learning style and rational learning style, suggesting a possible correlation [32]. However, it’s worth noting that these correlations’ strengths appear weak and not consistently aligned with expected directions.

Overall, these studies suggest that there may indeed be some correlations between learning styles and sensory processing patterns in Occupational Therapy students. However, it’s important to note that the strengths of these correlations appear weak and inconsistent across different studies. Previous research has highlighted various factors that influence learning styles and sensory processing, indicating that examining only one factor related to each may present limitations.

Learning styles are a combination of beliefs, preferences, and behaviors individuals employ to facilitate learning in specific situations. These styles, like abilities, are somewhat shaped by an individual’s interaction with their environment and can evolve over time. They are not static and can change depending on various factors such as the learning environment, individual characteristics, subject matter, level of knowledge, experience, and personal expectations. Thus, learning styles may be influenced by temporal factors, environmental conditions, and the evolving demands of life, highlighting the need to consider this dynamic nature in research investigations [33].

However, it is important to recognize that tailoring the introduction of learning styles to match learners’ characteristics can enhance the learning process by personalizing the content based on individual preferences and characteristics [34]. Moreover, university education plays a crucial role in fostering abstract thinking skills and assisting students in addressing complex and relative issues. Therefore, there is a need for educational strategies that progressively transition from objective and experiential learning to abstract and intellectual learning. Each technological and media product in education serves as a unique means to convey knowledge [35].

The fifth research question addressed in our study was, “Is there a correlation between learning steps and sensory processing patterns among Occupational Therapy students?” The study findings revealed no significant correlations between these variables overall. However, an interesting observation emerged concerning female students, identifying a correlation between low registration and learning steps. This suggests that gender differences may have influenced the results of the current study on certain aspects.

Only one search result discusses both “sensory processing” and “learning steps” in the context of Kolb’s experiential learning cycle. However, this source does not directly correlate these concepts. Instead, it presents a module that outlines the four stages of Kolb’s learning cycle. According to this module, each stage contributes unique aspects to the learning experience. However, it does not explicitly mention any correlations between these stages and sensory processing patterns [36].

While one search result explored the connection between “learning steps” and “sensory processing” in the context of gender, it did not establish a direct correlation between the two. This study evaluated the learning styles of medical undergraduates and examined the gender-specific relationship between learning style and academic performance [22]. However, it found no statistically significant correlation between gender and learning styles. Other search results shed light on the relationship

between learning styles and sensory processing patterns but did not address gender-specific differences. For instance, one study investigated the potential association between sensory learning style and rational learning style and identified a potential correlation [32]. Although no direct correlation exists between learning steps and sensory processing patterns concerning gender, these studies underscore the significance of considering sensory processing patterns and learning styles in occupational therapy education.

Given our census sampling approach, it's essential to acknowledge that this study had limitations, such as including all students without considering their psychological and psychiatric backgrounds. Previous research shows these factors could potentially influence sensory processing patterns. Therefore, future studies should aim to address this limitation by incorporating larger sample sizes and considering participants' psychological and psychiatric backgrounds, particularly with attention to gender differences.

## Conclusion

Based on the findings, there is no correlation between learning steps, learning styles, and sensory processing patterns. However, there may be a correlation based on gender, particularly in low registration sensory patterns. Therefore, our study highlights the importance of conducting future research on this topic, with a specific focus on gender differences and considering the mental health conditions of participants.

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## Authors' Contribution

All authors contributed to the conceptualization and design of the study. SGh performed material preparation, data collection, and analysis. SGh, HB, and SK wrote the first draft of the manuscript, and all authors reviewed and approved the final manuscript.

**Conflict of Interest:** None declared.

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