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ADAPTING TEACHING METHODS TO KOLB'S LEARNING STYLES: A STUDY IN INSTRUCTIONAL OPTIMIZATION

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ABSTRACT

Each learner is unique in the way they learn. In this context, personalized adaptive learning intervenes as a solution to adapt the presentation and content to the needs and preferences of learners in online education, but it remains ineffective if it does not take into account the characteristics and preferences of the learner in terms of learning method. This article focuses on the relationship between Kolb's learning styles and corresponding teaching methods. In order to explore this problem: first, we must define the learning style of each learner using the kolb LSI 3.0 inventory, which is a tool for measuring the cognitive characteristics of learners in order to determine their learning style. dominant learning. Second, its learners will be grouped according to their common learning style using the k-means clustering algorithm. Then, the teaching methods used in this study will be classified from 1 to 5 according to the learning preferences of the 68 high school girls from public scientific and technological education in Morocco, chosen for this study. Finally, the authors chose the linear regression method to predict the teaching methods corresponding to each learning style. The results showed that learning style has an undeniable impact on the choice of teaching methods. This work aims to help designers personalize their teaching based on individual methods and create a more effective learning environment.

Keywords: Adaptive and Personalized learning, Clustering algorithm, Kolb's learning style, Learning methods, , Linear regression algorithm.

INTRODUCTION

According to Kolb, the learning style refers to the manner adopted by a learner to accomplish a task or approach a situation. It focuses on a learner's preferences and behavioral skills. Kolb's learning cycle describes four styles: Divergent ,preference for observing and thinking, Assimilative ,preference for acquiring abstract knowledge and thinking, Convergent, preference for applying knowledge in situations practices, and accommodator, preference for experimentation and action [1]. The correspondence between Kolb's learning styles and learners' preferences for teaching methods is a theme that piques our interest in understanding how learners' learning styles relate to their preferences for teaching methods, [2].

According to, Sternberg an al. It is obvious that learning methods are varied and different learners have different learning methods, everyone adapts to different circumstances and goals. Understanding which learning method is most appropriate for each situation and for each learner is important when designing an online course or educational activity and will allow designers and learners to better leverage their skills and abilities to resolve their situations while benefiting from effective learning, [3]. Our work is to explore the complex and multi-factorial relationship between a learner's learning style at the teaching method that suits them and enable teachers or designers to adapt their methods to meet different learning styles in terms of educational adaptation.

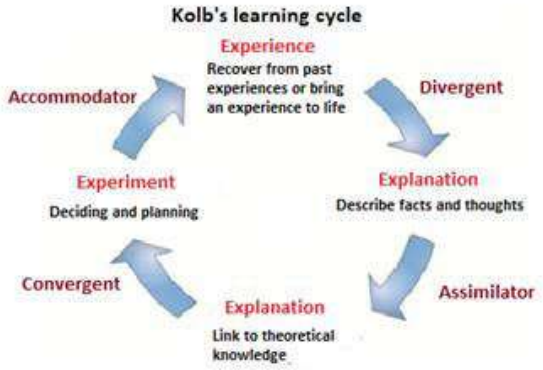
This article is based on an experimental study based on an ILS questionnaire from Kolb, presented online to a sample of 68 high school students in science and technology in Morocco, the responses were processed by the clustering algorithm, k -means to classify the 68 learners, according to the fourth styles of Kolb, then another form is offered to the same learners to classify the proposed methods according to their preferences with an index from 1 to 5, the linear regression algorithm is used to predict the correspondence between Kolb's learning styles and learners' preferences for teaching methods. The results showed that learning style had a significant effect on the choice of teaching methods.[4]

THEORETICAL FRAME

According to Honey and Mumford,[5]. The learning style is a description of the attitudes and behaviors that determine an individual's preferred method of learning,[6]. Drawings on Kolb's model as a flexible and stable learning style , based on two dimensions: Perception and processing, in this section we will present Kolb's theory and the styles resulting from his learning cycle with the learning style inventory, then the preferences for learning in the Kolb cycle will be detailed in a table to put an end to the learning methods and the criterion of choice,[7].

I. Kolb's theory

Kolb, developed a model of experiential learning, based on experience for the acquisition of knowledge and skills. Kolb presents this form of learning through a 4-phase cycle: Experience, Explanation, Explanation and Experimentation,[2].



Graphique 1: Kolb Cycle Inspired by Kolb's Experiential Learning Cycle

According to graphique 1: Learning always begins with experience, that which is perceived by the senses, the external or internal senses. The second phase explanation, the first step back from awareness and reflection, in this phase the implicit is made explicit. Experience is made conscious, in its exterior facts and interior thoughts dimensions. It is about describing what happened, but also the reflection of and on the experience. The 3rd phase is the explanation, the 2nd step back which presents the link with previous knowledge, with theories and interpretation, conceptualization, theorization. The 4th phase is experimentation, regulation, decision, planning objectives, means, progress, etc, [8].

Ii. The Kolb Cycle and Learning Styles

Kolb's model, shown in Figure 2, begins with a concrete experience from which a teacher can identify a question or problem encountered. Reflecting on this experience allows you to analyze it and identify elements that raise specific questions. From this analysis, it becomes possible to formulate a generalization or a personal theory which should be able to apply to all similar situations, or at least to most of them. This generalization can then be operationalized and put into practice to resolve the questions initially identified[9]. According to Figure 1, illustrates the learning cycle and styles of Kolb, [2]. Each phase favors the educational strategies most likely to promote a certain method of knowledge construction. By combining phases two by two, in the kolb cycle, we will have four learning styles defined according to [4], as:

- The divergent will prefer phases 1 and 2. He is imaginative and interested in people and emotions. Learners like to learn from concrete materials.
- The assimilator, for his part, prefers phases 2 and 3. He likes to create theoretical models and is less interested in people and practical applications of knowledge. Learners tend to follow the course step by step in a linear fashion.

- The convergent is found in phases 3 and 4. The convergent prefers to take care of objects rather than people. He is practical-minded and tends to be less emotional. The learner prefers to learn by thinking and working alone
- The accommodator identifies with phases 1 and 4. He is very intuitive and this helps him find new solutions to problems. He adapts easily to new situations. Learners prefer to learn by trying things and working in groups.

III. Learning Style Inventory

Many theories propose that learners in educational settings exhibit distinct differences in perceiving, analyzing, processing, and expressing their point of view through their preferred learning style. Consequently, learners can be categorized according to their primary learning style.[10] These theories assume that individuals learn in diverse ways and that tailoring instruction to accommodate these learning styles can enhance the educational experience. To identify learning styles based on Kolb's learning style model, Kolb developed the Learning Style Inventory (LSI). The LSI consists of a questionnaire comprising 12 questions across two dimensions, A and B. Learners are asked to rank four sentence endings corresponding to four learning styles, with 4 indicating the strongest preference and 1 indicating the least preference. This study investigates the influence of learning styles on learners' approaches to teaching and learning in online learning systems. The findings of this research are expected to assist educators and instructional designers in developing more effective teaching methods that align with students' individual learning preferences.

IV. Preferences for Learning in the Kolb Cycle

According to Kolb, proposes that each learner can have learning preferences combining several styles, with a predominance for one or the other, their preferences are divided into four main categories:

- **Style Accommodator : Experimenter, Concrete and Experimental**

Appreciates activities that involve concrete, real-life interactions. Prefers learning through direct, concrete experience, hands-on activities, projects, learn by doing and experimenting on their own. Enjoys hands-on, interactive learning situations and solving real-world problems, and learning from their own experiences.

- **Style Divergent : Observer, Concrete and Reflective**

Appreciates demonstrations, concrete examples and case studies. Preference for careful observation and information gathering. Analyze situations before taking action. Enjoys observing others and learning from others' experiences. take the time to think and discuss before taking action.

- **Style Assimilator : Theorist, Abstract and Reflective**

Enjoys reading, researching, and studying concepts in depth, conceptual discussions and logical analysis. Preference for reflection, focusing on abstract concepts and ideas, taking time to reflect and understand before taking action. Enjoys self-analysis and constructive feedback.

- **Style Convergent : Active Abstract and Experimental**

Appreciates dynamic discussions focused on practical application, debates and concrete group projects, case studies. Preference for hands-on, active learning and conceptual experimentation. Apply abstract concepts in practical situations. Enjoys finding practical solutions to problems, applying knowledge in real-world contexts and working on concrete projects, [11].

Learning preferences may also vary depending on the context and the specific learning task. By taking these preferences into account when designing teaching and learning, it is possible to optimize learner engagement and performance, [12].

Kolb's theory emphasizes the importance of integrating the different phases of the learning cycle, concrete experience, reflective observation, abstract conceptualization, and active experimentation to promote comprehensive and meaningful learning. By adapting teaching methods and learning activities to meet different learning preferences, educators can create more inclusive and effective learning environments,[13].

V. Teaching Methods

Methods are the teaching approaches used by teachers to impart knowledge, develop skills, and facilitate student learning. According to Coffield, F., & al, and based on a systematic review of existing literature that examines the links between learning styles and teaching methods, There are different teaching methods, each with its own characteristics and objectives, [14].

Our work in this article is focused on some methods as criteria taken for this study such as:

- **Lecture:** This is a traditional method where the teacher presents information verbally in front of a class. Learners listen and take notes, [15].
- **Project-based Learning:** Learners are engaged in hands-on projects that allow them to apply acquired knowledge and skills. This promotes active learning, creativity and problem solving, [16].
- **Group Learning:** Learners work in teams to complete tasks or solve problems. This encourages collaboration, knowledge sharing and the development of social skills, [17].
- **Problem-based Learning:** Learners are presented with real-world problems or scenarios and must work individually or in groups to solve them. This promotes critical thinking, decision making and information seeking, [18].
- **Differentiated Instruction:** This approach recognizes that learners have different needs and adapts instruction based on those needs. Teachers provide different materials, resources and activities based on learners' learning styles, skill levels and interests, [19].
- **Game-based Teaching:** Games and fun activities are used to make learning more interactive and engaging. This stimulates active learning, motivation and the pleasure of learning, [20].
- **Flipped Classroom:** Learners study core concepts at home through online resources or readings, while in-class time is spent on hands-on activities, discussions, and projects. This promotes independent learning and collaboration in class, [21].
- **Multimedia Teaching:** The use of multimedia materials such as videos, visual presentations, and simulations to present information and concepts. This can make learning more interactive and make complex topics easier to understand, [22].
- **Competency-based Teaching:** This approach emphasizes the development of practical skills and transferable abilities rather than the simple transmission of knowledge. Learners are encouraged to apply their knowledge in real-world contexts, [23].
- **Experiential Teaching:** Learners learn by participating in hands-on experiences, such as internships, field trips, or community service projects. This promotes experiential learning, critical thinking and the development of professional skills, [24].

It is important to note that each teaching method has its advantages and limitations, [25]. Teachers can choose and adapt teaching methods based on content, learning objectives, available resources and individual characteristics of learners, [26].

PRACTICAL FRAMEWORK

Using this framework whose objective is to evaluate the relationship between learning style and teaching method in a practical way and adapted to the context of experiential teaching in the kolb cycle, [1], for this this part is organized in four stages:

- Identify learners' learning styles and learning preferences.
- Analyze data using AI algorithms

- Assess learners' learning preferences
- Match learning styles and teaching methods and Identify teaching methods that match learners' learning preferences.

This practical framework is a methodological or conceptual approach used to guide the practical implementation of the study that presents specific guidelines, procedures and recommendations for collecting data, analyzing results and interpreting conclusions.

I. The Approach Proposes or Methodology

The study was carried out among 68 first- and second-year secondary school students in a public technical high school in Morocco. The objective of this study was to determine students' dominant learning style using Kolb's Inventory of Learning Styles (ILS). This inventory is in the form of a questionnaire which explores the learning preferences of individuals according to the Kolb cycle. Learners selected the responses that best matched their own preferences, which were then analyzed using the K-means clustering algorithm to rank them based on the four styles: Divergent, Assimilative, Convergent, and Accommodating. Then it's learners must fill out a form according to each style with the learning methods given from 1 to 5 according to a margin of preferences, its data will be analyzed by the linear regression algorithm to predict the relationship between the style and the methods which correspond the best, and finally a discussion presents the results and interpretation with recommendations to guide teachers and designers in the implementation of specific teaching methods for each style according to kolb.

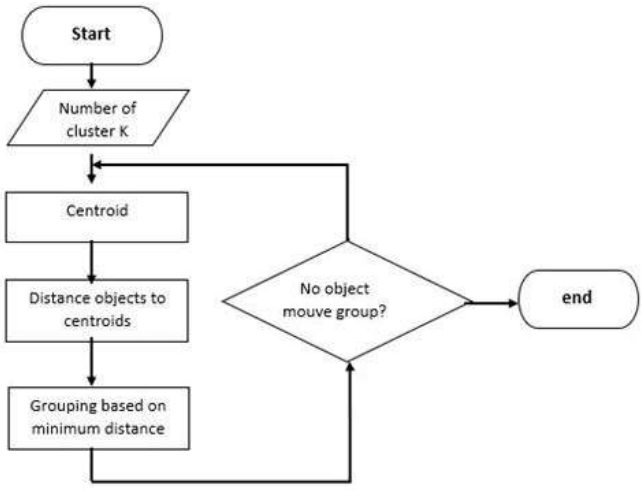
II. Learner Characteristics

The learners subject to the experiment are 68 girls from the science and technology high school, including 47 boys and 21 girls, with varied characteristics and preferences depending on their learning style and their preferred methods for learning. effective.

RESEARCH VARIABLES INCLUDE:

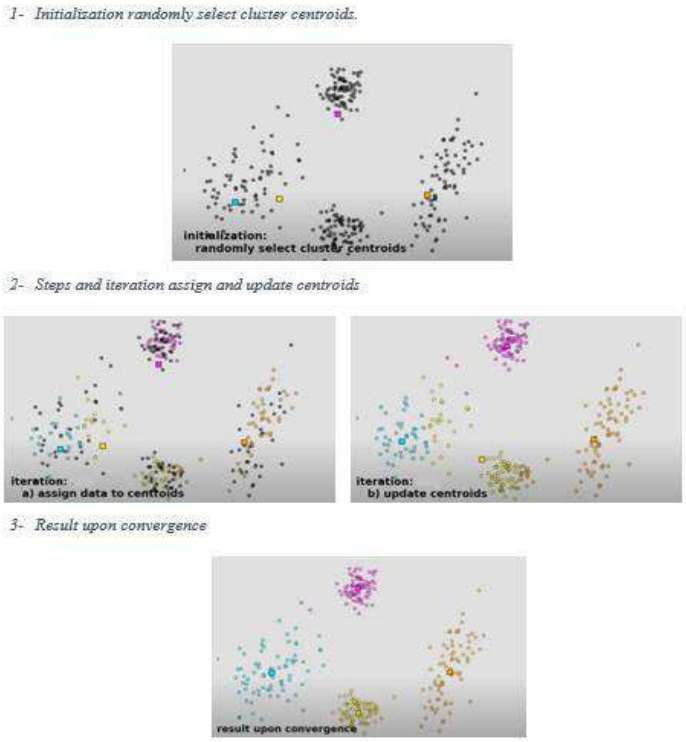
- Independent Variables: Kolb's Learning Style Groups.

Kolb's LSI made it possible to identify the subjects' preferences in terms of perception and processing of information. Subjects responded to Kolb's instrument comprising 12 questions on 4 dimensions and were classified as divergent, assimilative, convergent or accommodative. The k-means clustering algorithm is used to group the data based on the similarities between the values of the independent variables. By following the steps outlined in the flowchart above.



Graphique 2: Flow Diagram and Clustering Steps

At the practical level, the use of the K-means clustering algorithm, we take k=4 to the number of kolb styles, #data =300, to increase the readability of the figures we took 300 instead of 68 to the number learner.

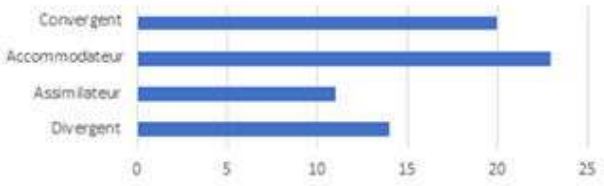


Graphique 3: The Steps of Preparing the Clustering Algorithm with K-Means

The results are classified in the following table according to the corresponding style and the percentage assigned and the statistical graph.

Tableau I: The Correspondence between Kolb's Learning Style, The Number Of Learners

Style	Numbers	Percentage %
Divergent	14	20.58
Assimilateur	11	16.17
Convergent	20	29.43
Accommodator	23	33.82



Graphique 4: Presentation of Learning Styles

- **Dependent Variables:**

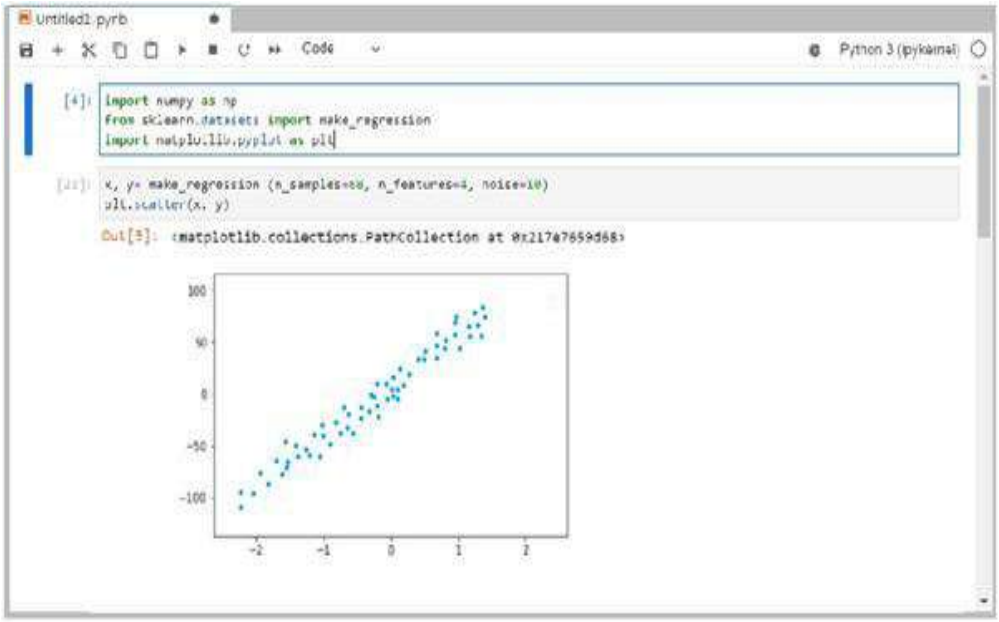
The dependent variables of this study are learning methods. Corresponding to the four learning modes of Kolb's learning style model, eleven different learning methods were identified as research variables in this study. These variables were measured when learners completed a form to rank the 11 methods. learning chosen according to degrees from 1 to 5 according to their preference for each method such as: lecture, project-based learning, group

learning, individual learning, problem-based learning, teaching differentiated, game-based teaching, flipped classroom, multimedia-based learning, competency-based teaching and experiential teaching. Finally, collect data on styles and their reactions to different teaching methods. The use of the linear regression algorithm which presents an evaluation tool to obtain qualitative and quantitative information on the way in which learners perceive and appreciate the different appropriate teaching methods, [27]. Case of learning styles according to Kolb:

Tableau 2: The Data Extracted from the Forms Filled Out Learners

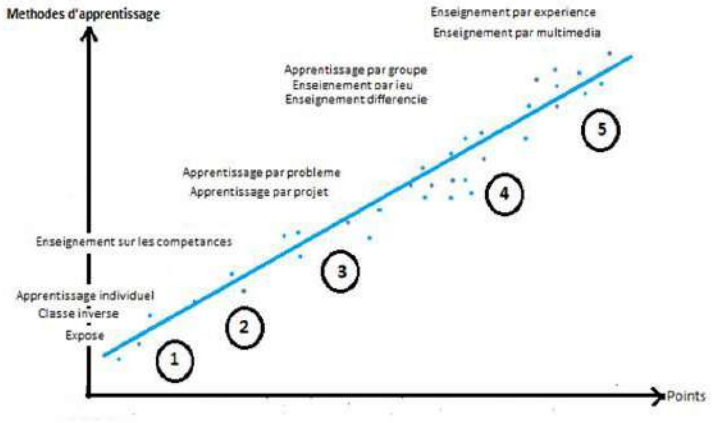
Learning Methods	Preference Divergent	Preference Assimilator	Preference Convergent	Preference Accommodator
Individual learning	1	5	5	1
Project-based learning				
Group learning	3	4	5	5
Problem-based learning				
Game-based teaching	4	2	1	4
Differentiated teaching	3	3	5	5
Reverse class				
Multimedia teaching	4	3	2	4
Teaching skills				
Exposed	4	1	1	4
Teaching by experience				
	1	4	2	1
	5	5	3	3
	2	4	4	3
	1	5	5	2
	5	2	4	5

- **The Program Associates on Anaconda Jupiter on Python:**



Graphique 5: The Algorithm on Python

- **The diagram associates with the divergent case, analyze by the method of the linear regression algorithm**



Graphique 6: The Divergent Diagram, Analyzed by the Method of Linear Regression Algorithm

INTERPRETATION

The diagram is a scatter graph which represents the score from 1 to 5 given by a learner to the learning method most appropriate to his performance according to kolb's learning style, if we try to draw a line which presents the trend of this graph, some points will be above while others will be below, while the best line is the one which will minimize the distance between these points, it is the line of linear regression:

$y=1.109x-120.08$. (1)

The correlation coefficient rule is given by [25]:

$$r=\frac{\sum[(xi-\bar{x})(yi-\bar{y})]}{\sqrt{\Sigma(xi-\bar{x})^2 * \Sigma(yi-\bar{y})^2}} \qquad (2)$$

by applying the rule (2) we find that: $r=0.98$

The correlation coefficient shows to what extent the independent variable affects the dependent variable. It is the intensity of the relationship between the data and the line which models it, it is a strong correlation which allows us to strengthen the understanding of the relationship between learning style and teaching method.

- **The Correspondence Between Learning Styles and Methods:**

In the same way as previously, the analysis of the other assimilator, convergent and accommodating styles are grouped in the following table:

Tableau 3: The Correspondence between Style and Learning Methods

Styles de Kolb Methods E/A	Style Divergent	Style Assimilator	Style Convergent	Style Accommodator
Individual learning		X	X	X
Project-based learning	X	X		X
Group learning				X
Problem-based learning	X	X		X
Game-based teaching	X			X
Differentiated teaching				
Reverse class	X			
Multimedia teaching		X		

Teaching skills Exposed Teaching by experience	X	X X X X X		X

DISCUSSION

Based on these results, teachers and educators can adapt their teaching approaches according to learners' learning styles. There is a strong correlation between experimental learning style and preference for learning methods, if for example preference for project-based learning, they may include more hands-on activities and projects in their teaching to accommodate learners with this learning style.

Adapting teaching methods to students' learning styles has several advantages such as using a variety of learning materials and teachers can provide a diversity of learning materials to meet different learning styles. learning, such as the use of visual supports such as graphs, diagrams or videos for divergent learners, audio recordings or group discussions for convergent learners, and hands-on activities or simulations for accommodating learners. Once teachers have identified students' learning styles, they can adapt their teaching in several ways to meet individual needs, and adapt teaching methods to accommodate students' learning preferences, they can include presentations or demonstrations, encourage group discussions or oral explanations and integrate practical activities or concrete experiences to offer choices and options to learners so that they can select the learning methods that best suit their style, and choose between different types of activities, projects or resources that meet their learning preferences.

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