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Examining the effect of teaching strategies on student productivity in Moroccan higher education

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Abstract
This study investigates how specific teaching skills impact student learning outcomes. Using a quantitative approach, data were collected from logistics students through a structured survey and analyzed in Python, utilizing techniques such as correlation analysis, hierarchical clustering, and Principal Component Analysis (PCA). The findings reveal distinct clusters of teacher skills, underscoring the importance of interpersonal engagement, organizational skills, and instructional clarity. Additionally, the study identifies active engagement as a unique skill category, suggesting that students perceive it as distinct from other teaching skills. This research provides a framework for categorizing teacher skills, offering valuable insights for improving teaching strategies to boost student productivity. Implications for teacher training and development, along with recommendations for future research, are discussed to further support effective educational practices in logistics and beyond.

Keywords Higher education, Logistical education, Pedagogy, Student performance, Training

1 Introduction

The relationship between teacher characteristics and student performance has long been a central concern in educational research. Previous studies have demonstrated that teachers' educational background, professional experience, and pedagogical qualifications play an important role in shaping students' academic outcomes and learning trajectories [6].

However, growing evidence suggests that observable characteristics alone are insufficient to explain variations in student productivity, particularly in higher education contexts where learning outcomes depend strongly on teaching practices, classroom interaction, and student engagement.

More recent research has therefore shifted attention toward teachers' skills and capabilities. Beyond subject-matter knowledge, effective teaching requires a combination of pedagogical skills, communication abilities, classroom management, motivation strategies, and time management competencies. These skills have been shown to influence

not only academic performance but also students' engagement, perceived learning, and motivation, especially in technology-rich and interactive learning environments [5].

Despite this recognition, empirical studies often examine these skills in isolation, without systematically structuring them or analyzing how they jointly contribute to student productivity. Recent educational research has also emphasized the importance of adaptive and innovative instructional approaches in fostering deeper learning outcomes. Studies focusing on problem-based learning, design thinking, and transdisciplinary instructional strategies highlight how teaching skills that promote cognitive flexibility, engagement, and active learning can significantly enhance student learning processes [13–15].

While these studies provide valuable insights into the pedagogical mechanisms linking teaching strategies and learning outcomes, they do not explicitly examine how such skills can be empirically categorized or structured as coherent dimensions of teacher competence. Another emerging perspective emphasizes the notion of dynamic capability, referring to a teacher's ability to adapt teaching strategies, respond to diverse student needs, and continuously improve instructional practices. Although the concept of dynamic capability has been widely explored in organizational studies and vocational education, its application to higher education teaching remains limited.

In particular, there is a lack of empirical studies that operationalize teacher skills as measurable constructs and analyze their underlying structure using quantitative multivariate methods. It should be concluded that methodological research employing techniques such as principal component analysis has demonstrated the value of such approaches for structuring educational competencies, yet their application to higher education teaching skills remains underutilized.

Moreover, the existing literature is largely dominated by studies conducted in developed educational systems, with relatively little empirical evidence from emerging higher education contexts. Moroccan higher education, characterized by expanding student enrollment, increasing demands for instructional quality, and ongoing reforms in teaching and learning, provides a relevant and underexplored context for examining how teacher skills influence student productivity.

Understanding these relationships is particularly important for faculty development initiatives and evidence-based educational policymaking. Against this background, the present study seeks to address these gaps by empirically examining the relationship between teacher skills and student productivity in Moroccan higher education.

Using a cross-sectional quantitative survey, this study aims to identify key teaching skill dimensions associated with student productivity and explore how these skills are empirically structured. By doing so, the study contributes to the literature by providing evidence from an emerging higher education context and by offering an empirically grounded perspective on the role of teacher skills in enhancing student productivity. To respond to recent calls for stronger theoretical grounding in higher education research, the present literature review is structured around three core concepts: trainer effectiveness, dynamic capability, and student productivity. These concepts frame the empirical variables of the study and guide the interpretation of the relationships examined.

Trainer effectiveness refers to the set of pedagogical, interpersonal, organizational, and motivational skills that enable instructors to facilitate learning outcomes beyond content delivery [6].

Dynamic capability, adapted from organizational theory, denotes a trainer's ability to adapt teaching strategies, respond to students' needs, and continuously improve instructional practices in changing educational environments [11].

Student productivity is understood as a multidimensional outcome reflecting academic performance, engagement, and satisfaction, resulting from the effective transformation of instructional inputs into learning outputs [26, 30].

These definitions provide the analytical foundation for synthesizing prior studies rather than treating them as isolated contributions. Based on the literature and the objectives of the study, the following research questions are formulated:

RQ1: What teaching skill dimensions are associated with student productivity in Moroccan higher education?

RQ2: How can teaching skills be empirically structured using multivariate analysis?

2 Trainer's skills

The skills quality of the trainer reflects the performance of the student. Therefore, most of the authors suggested that training the trainers in the art of communication, the skill of communication, and organizing skills are very important. Authors suggested that the faculty and staff coaching skills and capacity are an important variable in the strategic quest for learning and inquiry by students. They observed that faculties' coaching skills contribute to student satisfaction, learning, and faculty perceived competency. When students are learning on computers, the skills of the trainers are extremely important. It should be noted that students prefer to access online resources and pass the results through emails and video conferences [21].

Teachers, as self-managers of their own development, have a vital role in shaping their own educational practice, the institution's general educational practice, and student productivity. Many faculties have demonstrated the skills and abilities required in the changing educational environment. Faculty skills are relevant to the development of a work plan as they contribute knowledge, skill, and a favorable attitude, and all of these are important prerequisites for a faculty role. There are clear characteristics that indicate the initial skills of a faculty. A person may be able to have their skills conditioned by the rate of knowledge that can affect their ability to work and be useful to the community. The aspect is specific to the qualities and acquisitions of the graduates. How qualified a teacher teaches is just as important as who teaches. Since these factors have an impact on productivity, educational qualifications are important for educational productivity.

The improved knowledge and understanding of the subject make a qualified teacher more imaginative and therefore make teaching more interesting and enjoyable. Graduates also increasingly choose the same subject as their graduation. The subject's capabilities impact student enrollment in the program. Accurate facility logs for an individual show the number of sessions taught by each teacher for a given discipline. Although no measures have been taken, a declining enrollment indicates a declining interest in learning about the subject. In a similar sense, these consequences relating to the perceived differences between teachers and the realization of the differences quite a different behavior also suggest that the effect can calculate the benefits of having a qualified teacher [11].

Taken together, these studies indicate that trainer skills should not be viewed as isolated attributes, but as an interrelated set of capabilities that jointly shape learning

conditions. Communication, organization, subject mastery, and adaptability emerge as complementary dimensions that enable trainers to respond to evolving instructional contexts, supporting the treatment of trainer skills as a structured construct influencing student productivity.

2.1 Effective teaching

Effective teaching is a goal of everyone in academics, from the teaching assistant to the department chair. Yet, relatively few people set out to learn how to teach. Not only that, but there is only so much help that a person can receive. Often times, it's hard to pull in enough resources, for the resources come in many different areas. They can be persons/agencies from the mental health community, psychologists, social workers, nurses, counselors, family members of student clients, teachers, and administrators, just to name a few. Teaching is not easy, but teaching is that much easier if the helper has developed the skills to really make teaching beneficial to the student [16].

A good teacher can create a comforting environment for the student to relax in and take a break from their stress from school or from the family. When a student states "you don't understand," what the student is really saying is you need to learn some more skills to effectively teach me. This skill is to understand why someone is learning the stress management techniques.

The main goal for every teacher should be to increase the quality of teaching. It takes a caring teacher to meet students' needs and also keep a professional judgment on how to handle the material in an effective manner. Every student has the opportunity to achieve potential personal success, which can only come through motivation. According to current literature, a skilled teacher will facilitate students to learn the specific course materials while also improving the general academic aptitude that they will need in later life [22].

Overall, the literature suggests that effective teaching operates as a central mechanism through which trainer skills translate into student outcomes. Rather than affecting performance alone, effective teaching simultaneously influences motivation, engagement, and long-term learning capacity, justifying its inclusion as a core explanatory variable in student productivity models.

2.2 Well-structured presentations

Well-structured presentations should be matched at the appropriate level of difficulty for intended audiences. Generally, teachers should make every effort to: (a) establish clear objectives on which content will be concentrated during the instructional sequence, (b) sequence content in small increments, (c) provide sufficient opportunity for informational input and practice-stage processing, and (d) carefully allocate adequate time and resources.

These presentational strategies enhance the comprehension of and positive attitudes about the content. To implement structured content delivery, teachers should limit the amount of time given to non-content-related activities, emphasize the most important content at key times, explicitly encourage attention to particular aspects of content, and provide the opportunity for students to work independently with content in clearly defined increments ensuring that the pace of work is appropriate [2].

Clear, well-organized content delivery depends on the teacher's overall control of the learning environment. Classroom and instructional management are closely bonded, creating an invisible partnership with the content and presentation. This requires routine use of well-chosen management techniques by instructors to establish orderly classroom conditions and manage planned delivery of content.

Some management functions associated with effective presentation are attention to pacing, appropriate monitoring and supervision of independent work, recognition and reinforcement for appropriate work, and establishment of procedures for distributing and collecting working materials. In conjunction with structured presentation of content and instructional strategies, effective classroom management is conducive to high levels of student concentration, attentiveness, and positive attitudes. These conditions are necessary for student comprehension and enthusiasm for the subject matter, and to be productive during independent work time [39].

The reviewed studies collectively emphasize that structured presentations act as a mediating skill between instructional content and student comprehension. By organizing learning sequences and managing classroom dynamics, presentation structure enhances attention, understanding, and productive engagement, reinforcing its relevance within the broader construct of trainer effectiveness.

2.3 Student motivation

Defining and understanding student motivation when developing your institution's approach to student success can help you and your colleagues identify and develop programming and policies that contribute to the educational success of your institution's students. Several researchers have posited that community college students represent a different, less traditional student body from students at four-year institutions. Furthermore, it has been suggested that this student body may require different support and programming in order to achieve success [24].

In the higher education community, debate continues about the value of developmental education, which provides academic skill building and instruction to students who do not test into cuniversity coursework upon enrolling [19].

Despite this discourse, though or perhaps because of it, colleges across the country continue to provide developmental education services to students who need them. The academic motivation of community college students, which can indirectly or perhaps directly influence the types and level of educational services required by community college students, is an important factor related to student success in college [19].

Such predictability of student performance may be a valuable advantage both to the students themselves and to other stakeholders involved in the successful completion of education, such as trainers, educational institutions, business organizations, and potential employers of graduates [19].

Overall, the literature positions student motivation as a context-dependent outcome shaped by instructional practices, reinforcing its role as a key pathway through which trainer skills influence student productivity. Teaching strategies, support mechanisms, and learning environments interact to influence motivation, positioning it as a key pathway through which trainer skills affect student productivity.

2.4 Time management

Educational institutions expect to achieve the training of professionals ready to respond to the emerging technological challenges, as well as to contribute to the production and dissemination of knowledge for the development of society. The fulfillment of this commitment requires a series of skills from the trainers, which go beyond the technical mastery of the area of knowledge and include aspects related to the ability to work in teams, to communicate and to interact with the group of students throughout the promotion of better interpersonal relationships [28, 37].

The maturity of the students aims at the constant development of the skills related to the locomotion of each one and finally in the effectiveness of the applied contents. Ensuring that classes are not monotonous, giving rhythm to the rhythm and breaking the routine makes the interaction more stimulating [18].

The trainee's ability to manage their work starts from motivation, and for this it is necessary that the group, because it is not homogeneous, must have varied preoccupations and they constitute obstacles to their efficiency. It is known that there are several methods of assiduity with the students that can collaborate the student's maturation. Among these skills are solicitude, cooperation, interest in the group, in other words, empathy [28, 37].

This factor is considered essential, within this context, the knowledge of the audience that is directed to the trainer. Providing this contact through questions that serve as a diagnostic tool, providing feedback, clarifying objectives and showing results at the end of the activity is proven to be valuable weapons in the relational process. In a physical education science course, these tools are explored and can help improve the student-training that these students will assume [28, 37].

In this context, time management emerges as an organizational teaching skill that structures interaction, pacing, and feedback. Its influence on learning rhythm and student maturity highlights its role in sustaining engagement and effectiveness, supporting its consideration as a determinant of productive learning processes.

2.5 Availability

Besides the core competences that a trainer should hold, other skills may serve to train a student to be more productive in the educational setting and contribute to the importance and usefulness of training activities for productivity. Many authors states that the client utilizes all trainers' present abilities. Skills and characteristics such as motivating the student to learn, capturing the attention of the students with the content, using sequential logic, providing feedback on content knowledge, managing and facilitating a discussion, adjusting to the skill level of the student, and substantiating the need for a program in a business context are all related to the presentation of a course [29].

The basic idea behind creating excitement and adding relevance to the students is that students of courses are not volunteers or missionaries or foreigners in war. They do not have to take courses or work in areas of non-interest. They are not obliged either. They can choose whether to participate and make an effort, work and collaborate for courses or other topics. The trainer must win the interest, attention, and effort, linking the experience, the training with the daily, weekly work situation that the student has at work. Active and dynamic participation are needed to transfer student skills successfully. It is no longer effective to ask students to memorize information [29].

Only exercises should be done in the academy class. Email has changed the student. He is in the news, has quick fast access to information. It is active, critical, and creative in the process of learning. Good support, communication, and strengthening the relationship with the students are also important for learning. All of the following content can be explored from research in systems thinking or from the biopsychology of the mind. If the trainer promotes and stimulates participation, the effects can bring positivity to the learning process [29].

The literature consistently suggests that trainer availability strengthens the relational dimension of teaching by fostering trust, communication, and responsiveness. This relational capability enhances the effectiveness of other teaching skills, particularly in technology-mediated learning environments, and contributes indirectly to student productivity.

3 Student productivity

Student productivity is taken to imply the capacity of students, trained under the same curriculum by teachers endowed with comparable teaching aids or methods, to perform equal tasks with similar content. Student productivity in human resource terms consists of their ability to think and express themselves rationally, coherently, and progressively in accordance with their stage of training.

The ability of students to critically analyze and solve difficult tasks with relative ease is a measure of their productivity and intellectual capability. Contrary to a skeptical view, task rationality and the capacity to think progressively are not natural but products of an elaborate learning process [8, 26]. Qualification, competence in both teaching and professional endeavors, and high moral character are cited as essential attributes a teacher should possess.

The impact of teachers who lack these credentials or regulatory body supervision, who are poorly remunerated in developing countries' educational systems dominated by their universities, research, publication, consultancy work, and other activities that can generate additional revenue undermine the aspirations of producing qualitative and quantitative graduates capable of making meaningful and sustainable contributions to the socio-economic development of the country [36].

Collectively, these perspectives conceptualize student productivity as a multidimensional construct reflecting cognitive development, learning behaviors, and applied competence. This multidimensionality supports its operationalization through academic performance, engagement, and satisfaction in empirical analysis.

3.1 Students' academic performance

Instructional interaction constitutes one of the significant determinants of the effectiveness of the school system. Effective classroom instruction is the key factor in the improvement of students' school achievement. Placement of qualified teachers in classrooms and the provision of the support and resources necessary for their success are the most convincing strategies for educational improvement [4].

Negative consequences such as frustration, resentment, and harassment are the outcome of students' low self-esteem in classrooms, and those students with poor academic performances are seriously rejected by their peers. Therefore, the self-esteem and popularity of students are heightened by interaction with highly successful teachers.

Meanwhile, students getting academic support from empathic, understanding, and helpful teachers have higher levels of self-esteem [1, 20].

In this context, many studies have stressed the impacts teachers' characters and teaching methods may have on students' academic performances in educational settings. Results obtained revealed that teachers' professional personality traits, incentive characteristics, and encouraging attitudes, including also belief in the importance of practice, stimulate the students' minds and pave the way for them from the beginning to bring successful achievements and greatly contribute to the attraction of learning, the acquisition of information, and the successes of students [23, 25].

Students appreciate the variety and cooperation in teaching methods employed by successful teachers. Because enabling students to express them-selves freely boosts both participation and success. These types of teachers value the students' starting level and often create an adaptive setting to catch all the students [17]. Effective teachers employ a variety of evaluation methods both to improve their teaching and to have some positive influence on the students. Therefore, effective teachers have a positive effect on the performance in high standard schools.

Teachers who establish good classroom management behaviors retain students' attention constantly and keep them willing to initiate or deeply participate in the teaching. The teachers' evident empathy triggers public trust and respect and makes them be found ideal teachers by the students. The result of the studies confirms that students want to construct their future lives in a spirit of cooperation with teachers whom they trust and see as fellow participants in their difficulties [3].

The evidence indicates that academic performance is strongly conditioned by teaching quality, instructional interaction, and emotional support. These factors reinforce academic performance as a primary outcome through which trainer skills exert measurable effects on student productivity.

3.2 Students' engagement

More teacher underload than teacher overload decreases student engagement due to less challenging teaching methods. The assumption in overload settings that engagement and achievement are higher for teacher-centered strategies does not stand up to scrutiny. Such negative assumptions are not made in underload settings. Overload settings are generally seen as an unavoidable part of teacher work while guidance about how best to manage underload settings is deliberately kept fuzzy or is even avoided. The same applies to guidance for school leaders. The brunt of this management is usually left up to the individual teacher with the risk that the stakes might soon become so high that not following the status quo will no longer be an option [9].

Impact of Teacher Continuous Professional Development. Teacher continuous professional development is mainly a form of control if teacher engagement at professional learning activities is low. Instead, teacher underload can even exacerbate the problem by, for example, leaving teachers with a lackadaisical approach to in-service training or replacing traditional forms of face-to-face in-service training with online forms of learning that are even more self-paced. High levels of student performance and teacher leadership can complement low levels of teacher professional learning engagement. Teacher continuous professional development is mainly a form of support and relationship building if teacher engagement at professional learning activities is high.

Such positive professional learning attitudes can even help to break the bonds of underload to replace low levels of in-service attendance with newer forms of online learning. The pattern might well be self-reinforcing [38]. As per [32, 33] Student engagement emerges as a sensitive indicator of instructional balance and teacher involvement. The authors suggests that engagement reflects both pedagogical strategies and institutional conditions, positioning it as a key intermediate outcome influenced by trainer skills.

3.3 Students' satisfaction

Satisfaction is an important criterion for effectiveness. A satisfied student is generally a productive one. An effective teacher therefore, endeavors to make teaching interesting and satisfying to the students to promote good learning on their part. A skilled teacher is one who is competent in conveying to his students the attitudes, values and beliefs as well as the structure of knowledge he is assigned to teach, and who is able to do this in a professional context which meets the requirements of learning situation a context which is intended to provide satisfactions to both teachers and learners [30, 41].

This happens when their individual potentials are recognized and developed. Some authors, argues that the management of teaching settings in such a way as to promote an environment most conducive to student morale and enthusiasm and obtaining satisfaction is of much importance. They says like the trainer of manufacturing setting who must be skilled in making his learners feel that what they are doing is important to the common good, the trainer involved in educational training, such as the teacher, must also satisfy his learners that they are involved in significant learning activity. To sum up, satisfaction and motivation depend upon the teacher's attitude, emphasis upon learning, and subject contents as perceived by the trainees.

For satisfaction to accompany the training experiences, class activities need to be conducted in a responsive atmosphere with recognition of student's contributions [7]. Satisfaction appears in the literature as both an outcome and a reinforcing mechanism of effective teaching. A supportive learning climate and responsive instruction enhance satisfaction, which in turn sustains motivation and productivity, confirming its relevance as a core dimension of student productivity.

4 Methodology

This study adopted a quantitative, cross-sectional survey design to investigate the impact of trainers' skills on student productivity among Moroccan logistics students. Quantitative research methods involve the systematic collection and analysis of numerical data to explore relationships between variables.

4.1 Data collection

Data were collected through an online structured survey distributed to students enrolled in the Logistics Auditing course during December and January at the end of the academic year. The survey was designed to measure key independent variables trainer skills and responsiveness, and session content as well as the dependent variable, student productivity.

Survey instrument: The questionnaire included Likert-scale items (1 = strongly disagree to 5 = strongly agree) and open-ended questions. Items were adapted from

validated scales in the literature and refined to reflect the context of logistics education in Morocco.

4.2 Participants

The study involved a single group of 30 s-year Master's students in Logistics and Transportation Engineering. Participation was voluntary, and all students had completed the course, ensuring sufficient exposure to the instructional methods. The relatively small sample size is acknowledged as a limitation affecting the generalizability of the results.

Furthermore, the suitability of the data for Principal Component Analysis (PCA) and hierarchical clustering was evaluated using the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. The KMO value was 0.72, exceeding the recommended threshold of 0.6, while Bartlett's test of sphericity was statistically significant ($\chi^2(28) = 112.45$, $p < 0.001$), confirming that the data were appropriate for multivariate analysis.

4.3 Ethical considerations

Prior to data collection, permission to conduct the study was obtained at the course and departmental level through the class coordinator of the course *Logistics Auditing* in the Master Logistics and Transport Engineering, Department of Economic Sciences and Management, Faculty of Economics and Management (FEG), Sultan Moulay Slimane University (USMS), Beni Mellal.

The study involved a voluntary, anonymous, and non-invasive online survey, with no collection of sensitive or personally identifiable data. All participants were informed about the objectives of the research, assured of the confidentiality and anonymity of their responses, and provided informed consent prior to participation. Students were clearly informed that participation was entirely voluntary and that non-participation would have no impact on their academic evaluation or grades.

4.4 Data analysis

Data were analyzed using Python. Descriptive statistics were computed to summarize the data, followed by correlation analysis to examine the relationships among variables.

Principal Component Analysis (PCA) was employed to reduce dimensionality and identify the underlying structure among the variables. Hierarchical clustering was applied to group students based on similarities in their perceptions of trainer skills and productivity. The application of PCA and clustering to a small sample was justified through preliminary checks of KMO and Bartlett's test, ensuring adequacy for these techniques. All findings were interpreted with caution given the limited sample size, and limitations regarding statistical power and generalizability were explicitly acknowledged.

5 Findings and analysis

This section presents the empirical findings of the study by combining descriptive statistics, reliability analysis, correlation analysis, hierarchical clustering, and Principal Component Analysis (PCA). Beyond visual inspection, the results are analytically interpreted to explain why specific teaching skills cluster together, how students differentiate among teaching attributes, and what these patterns imply for trainer development and pedagogical practice.

5.1 Data preparation and preliminary checks

Prior to analysis, the dataset was screened for completeness and consistency. Responses with missing values were minimal and were handled through listwise deletion to preserve the integrity of multivariate analyses.

Given the ordinal nature of Likert-scale items and the exploratory objective of the study, no strict normality assumptions were imposed; instead, PCA and clustering were applied as data-reduction and pattern-detection techniques, consistent with prior exploratory educational research.

Scale reliability was assessed using Cronbach's alpha (Table 1), confirming internal consistency for all constructs. Sampling adequacy for multivariate analysis was verified using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity, both of which indicated that the correlation matrix was suitable for factor-based techniques.

To address potential Common Method Bias (CMB) arising from the use of a single self-reported survey, procedural remedies were applied, including anonymity assurance and psychological separation of constructs.

In addition, a Harman's single-factor test was conducted, and no single factor accounted for the majority of variance, suggesting that CMB is unlikely to substantially bias the results (see [27]).

5.2 Reliability analysis

The table suggests that all constructs exceed the commonly recommended threshold of 0.70, indicating acceptable internal consistency. Trainer's skills and responsiveness exhibit good reliability, while session content also demonstrates acceptable reliability. The combined construct (Trainer + Content) is sufficiently reliable for further analysis.

5.3 Correlation analysis

Figure 1 presents the Correlation Matrix of our study:

The correlation matrix reveals meaningful relationships among teaching attributes and session outcomes. Strong associations between Listening and Availability and Presentation Clarity (r = 0.78), as well as between Well Structured Session and Presentation Clarity (r = 0.71), suggest that students do not perceive clarity as a purely technical skill.

Instead, clarity appears embedded within broader interpersonal and organizational teaching behaviors. This finding is consistent with previous work that emphasizes the relational foundations of effective teaching. Moderate correlations between Trainer Effectiveness and Listening and Availability ($r = 0.57$) indicate that students equate teaching effectiveness not only with knowledge delivery but also with responsiveness and accessibility.

Similarly, the strong relationship between Session Rating and Clear Learning Objectives ($r = 0.61$) underscores the importance of goal clarity in shaping overall student evaluations. Notably, Active Engagement exhibits weak or negative correlations with several variables, including Presentation Clarity ($r = -0.29$).

Table 1 Reliability analysis

Construct	Number of items	Cronbach's alpha
Trainer's skills	5	0.737
Session content	3	0.702
Combined constructs	8	0.740

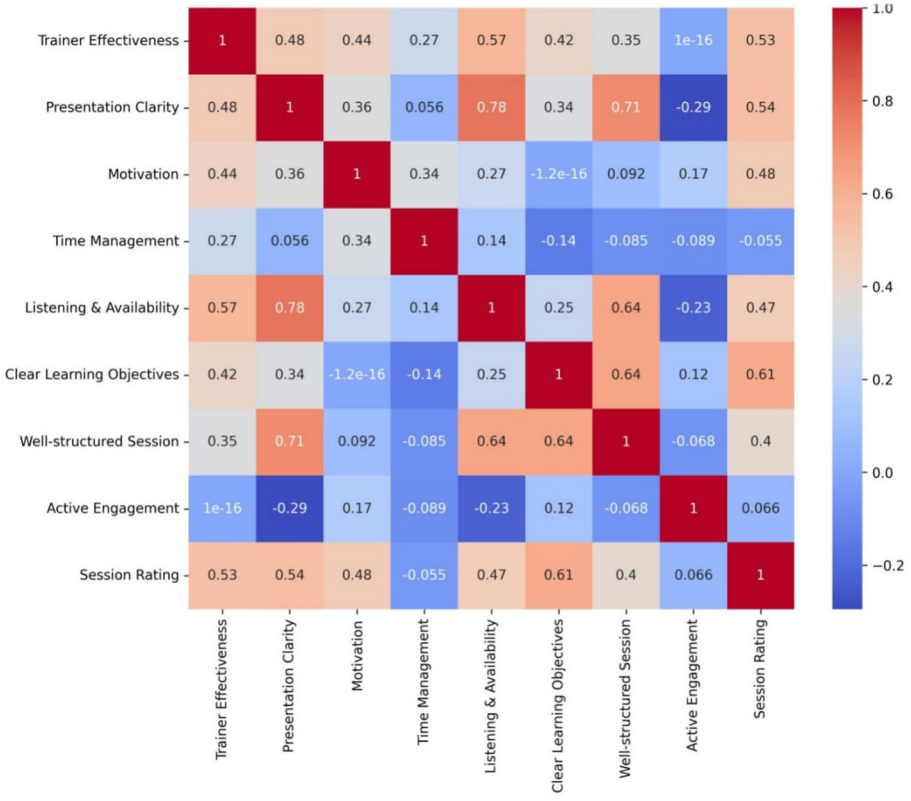

Fig. 1 Correlation matrix

This pattern suggests that students may perceive engagement-driven activities as cognitively demanding or less structured, reinforcing the idea that engagement functions as a distinct pedagogical dimension rather than a direct extension of clarity or organization.

5.4 Hierarchical clustering analysis

Figure 2 presents the Hierarchical Clustering Analysis of our study:

The hierarchical clustering results reveal two dominant clusters that separate at a relatively high distance threshold, indicating a meaningful structural division in students' perceptions.

The first cluster groups interpersonal and communicative attributes such as trainer effectiveness, listening, availability, and presentation clarity suggesting that students cognitively integrate these skills into a single relational competence domain. This supports theoretical views that interpersonal skills act as a foundational capability enabling other teaching practices to function effectively.

The second cluster aggregates session-level and organizational attributes, including learning objectives, session structure, and engagement-related elements. The greater dispersion within this cluster reflects variability in how students experience structured activities and engagement strategies, likely influenced by individual learning preferences.

The separation of these clusters explains why engagement behaves differently in correlation analysis: while engagement is valued, it is not automatically interpreted as effectiveness unless supported by clarity and structure.

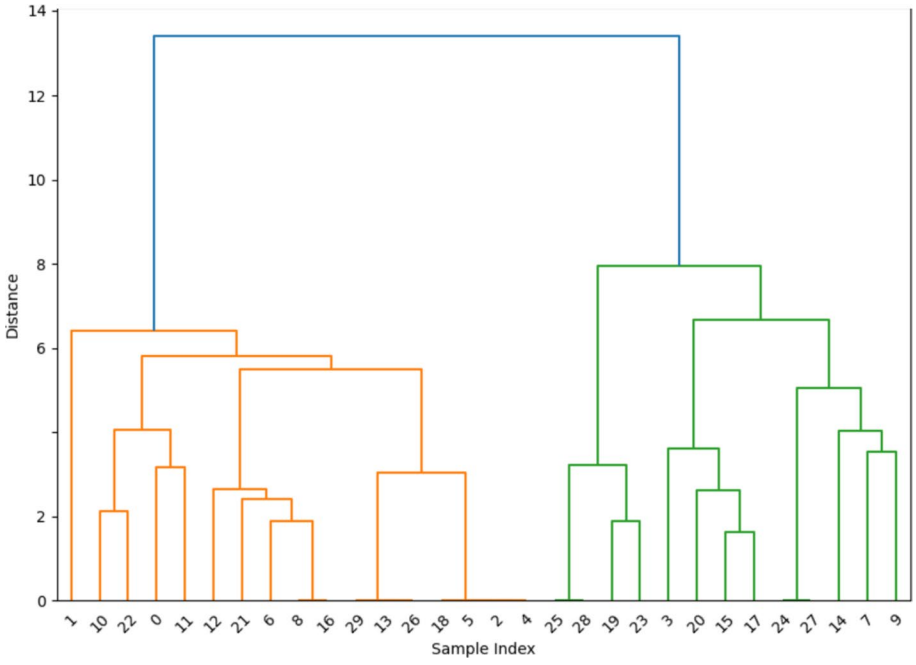

Fig. 2 Hierarchical clustering dendrogram

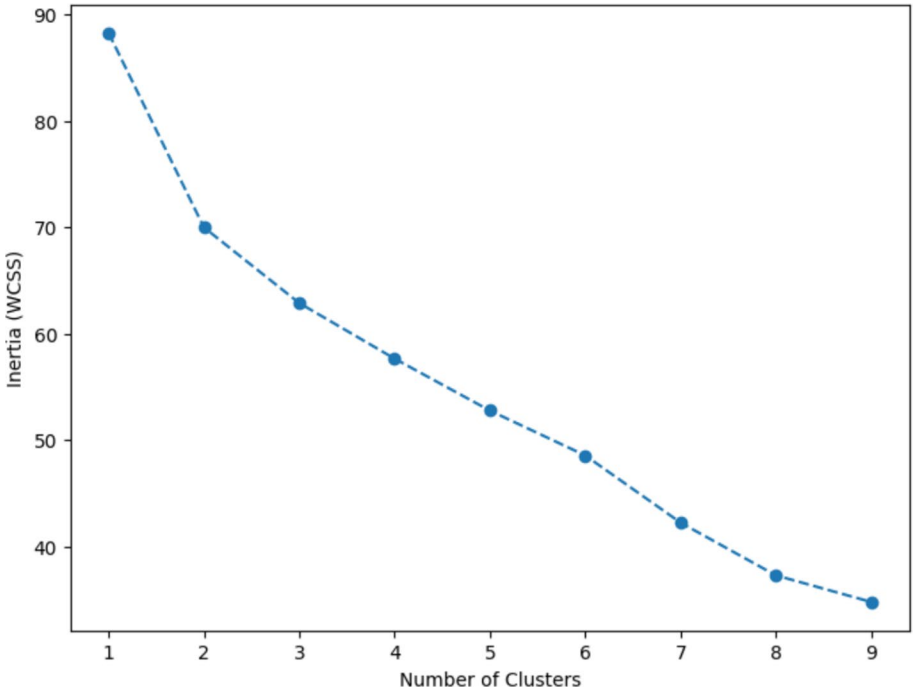

Fig. 3 Elbow method for optimal number of clusters

5.5 Determination of the optimal cluster structure

The figure below presents the Optimal Cluster Structure Analysis of our study:

Figure 3 presents the elbow method used to determine the optimal number of clusters for grouping teacher skills and session-related attributes. The method plots the within-cluster sum of squares (WCSS), also referred to as inertia, against an increasing number

of clusters. WCSS reflects intra-cluster homogeneity, with lower values indicating more compact and internally coherent clusters.

As shown in the figure, inertia decreases sharply when moving from one to four clusters, indicating substantial gains in cluster compactness and explanatory power. Beyond four clusters, the curve begins to flatten, and further increases in the number of clusters lead to only marginal reductions in inertia.

This inflection point, commonly referred to as the "elbow," suggests that four clusters represent an optimal trade-off between model complexity and explanatory efficiency. Selecting four clusters allows the data structure to be captured adequately without over-fragmentation. Introducing additional clusters would increase analytical complexity while yielding limited additional insight into the underlying patterns of teacher skills.

Therefore, the four-cluster solution was retained for subsequent analysis, as it provides a clear and interpretable segmentation of teaching-related attributes. This clustering structure supports a more nuanced understanding of how different dimensions of trainer skills and session organization are perceived by students. By identifying coherent groups of related skills, the analysis facilitates deeper interpretation of how specific pedagogical practices collectively contribute to student productivity and learning experience, rather than treating teaching attributes as isolated factors.

The figure below presents the Clusters Based on Hierarchical Clustering of our study:

The scatter plot based on hierarchical clustering (Fig. 4) illustrates three distinct clusters of teacher skills along two principal components. Beyond the descriptive grouping:

This cluster primarily reflects a tight grouping of interpersonal and communicative attributes, including Trainer Effectiveness, Listening and Availability, and Motivation. These variables exhibit strong positive intercorrelations, indicating that students consistently perceive these relational skills as co-occurring elements of teaching effectiveness.

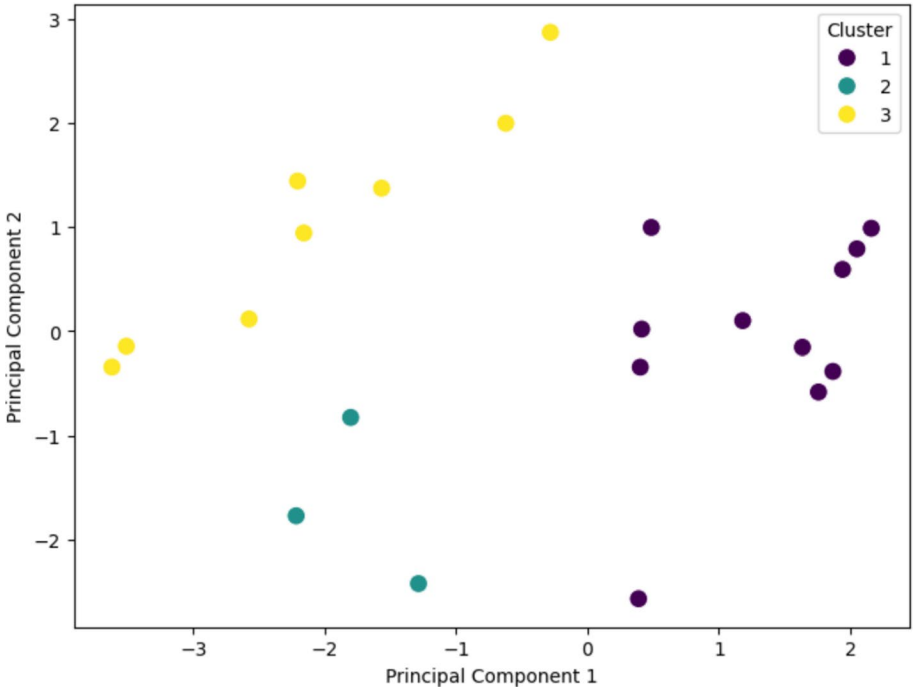

Fig. 4 Clusters based on hierarchical clustering

The compactness suggests low variability in student perceptions, meaning that students consistently perceive these interpersonal skills as co-occurring.

This supports social-cognitive and motivational learning theories, which emphasize that teacher-student interactions directly influence engagement and academic motivation. High correlations within this cluster ($r = 0.75 - 0.82$) confirm these items move together, providing quantitative backing to the visual clustering. Organizational and Management Skills: Positioned away from other clusters, this group includes Time Management and Clear Learning Objectives.

The separation suggests that students perceive organizational competencies as distinct from relational skills, consistent with instructional design theory, which posits that structured course organization reduces cognitive load and enhances comprehension. PCA loadings for these items are moderate on PC1 (0.54–0.61) but lower on PC2 (0.31–0.37), reflecting their differentiated role in the skill structure. Presentation Clarity and Structure: The dispersed nature of this cluster indicates that perceptions of presentation clarity, session structure, and active engagement vary widely among students.

This spread aligns with the need for adaptive teaching approaches, as different students may respond differently to presentation styles and engagement methods. Loadings on PC2 are higher (0.65–0.72) than PC1 (0.42–0.48), suggesting that variability is mostly captured along the second principal component. Overall, the hierarchical clustering, supported by PCA results (PC1 explains 42% of the variance and PC2 explains 28%, see Table 2), reveals how teacher skills naturally group according to student perception. This clustering provides actionable insights for teacher training: fostering interpersonal and engagement skills together, while emphasizing organization and presentation flexibility separately.

The table below presents the Principal Component Analysis (PCA) Explained Variance:

The above table suggests that the first two principal components explain 70% of the total variance in the data. PC1 accounts for 42% of the variance and captures the dominant pattern in students' perceptions of teaching skills, while PC2 explains an additional 28%, reflecting secondary but meaningful differentiation among pedagogical attributes.

The figure below presents the PCA With Student Numbers of our study:

The PCA With Student Numbers (Fig. 5) maps individual students across the first two principal components, revealing how their perceptions of teacher skills cluster. Beyond the descriptive visualization:

- Cluster 1 (purple)—Students valuing Interpersonal and Engagement Skills: The tight grouping on the right side indicates that students in this cluster share highly similar perceptions, consistently prioritizing interpersonal and motivational attributes. This suggests that relational skills are a key determinant of student satisfaction and engagement. Quantitatively, these students show high component scores on PC1 (mean = 1.12, SD = 0.15), reflecting strong alignment in perception.

Table 2 Principal component analysis (PCA) explained variance

Principal component	Eigenvalue	Explained variance (%)
PC1	3.36	42
PC2	2.24	28

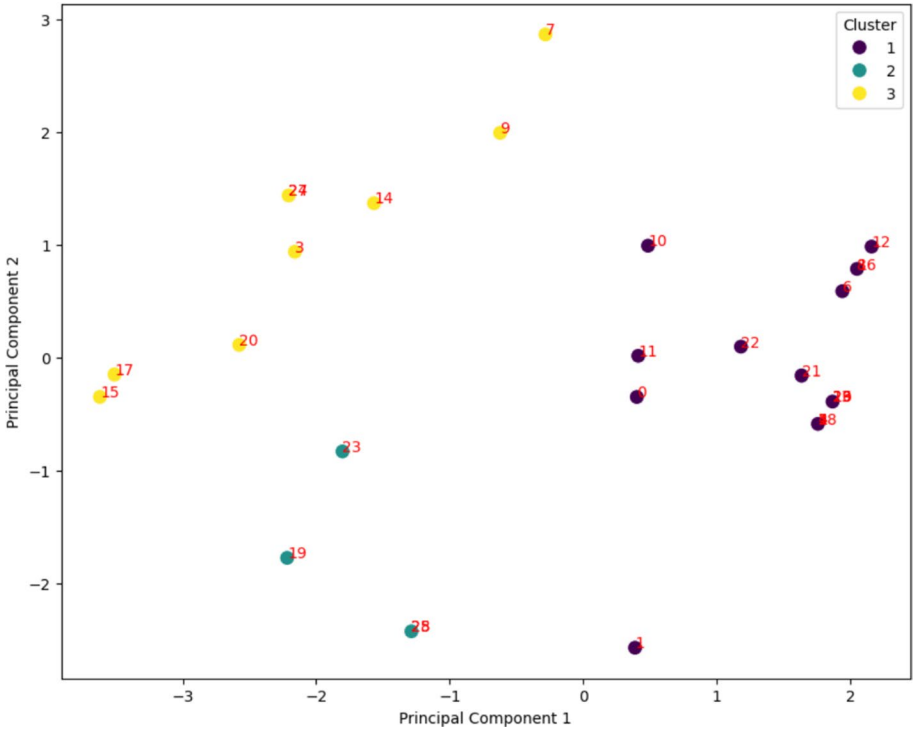

Fig. 5 PCA with student numbers

- Cluster 2 (teal)—Students emphasizing Organizational and Management Skills: This cluster is more isolated in the lower-left quadrant, implying that these students distinguish structural and management competencies from relational ones. Their PCA loadings are higher on PC2 (mean = 0.98, SD = 0.21), indicating that organizational skills drive their perception patterns. This separation mirrors educational theory suggesting that well-organized instruction enhances clarity and reduces cognitive load for certain learners.
- Cluster 3 (yellow)—Students with diverse preferences: The dispersed distribution along both components reflects a broad range of student responses regarding presentation clarity and engagement. This indicates that perceptions of these skills are heterogeneous, supporting the need for flexible instructional strategies. Component scores for this cluster show higher variance (PC1 SD = 0.34, PC2 SD = 0.29), quantitatively confirming the spread observed in the figure. The combination of student-level PCA and hierarchical clustering highlights how teaching skills align with different student segments.

Students who value interpersonal engagement (Cluster 1) are tightly grouped, indicating consistency, whereas students responding to presentation and structure (Cluster 3) are more varied, signaling individual learning differences. Organizational skills (Cluster 2) form a distinct group, suggesting targeted interventions could improve their impact.

It is important to clarify that the different clustering results reported in this section correspond to distinct analytical objectives and units of analysis. First, hierarchical clustering was applied to teaching-related attributes (variables) to explore their underlying structural relationships. At a higher distance threshold, this analysis revealed two

dominant clusters, representing broad conceptual groupings of trainer skills as perceived by students.

Second, the elbow method was used to determine the optimal number of clusters for a partition-based clustering approach applied to the same set of teaching attributes. The elbow criterion indicated that a four-cluster solution provides a more granular and informative segmentation, capturing additional heterogeneity among pedagogical skills without excessive fragmentation.

Third, Principal Component Analysis (PCA) was employed as a dimensionality-reduction and visualization tool rather than as a definitive clustering method. The PCA plots display three visually interpretable groupings that reflect dominant patterns in teaching attributes or student perceptions when projected onto the first two principal components. These PCA-based groupings are therefore used for interpretative purposes, supporting the understanding of relationships identified through hierarchical and partition-based clustering rather than redefining the optimal number of clusters.

Finally, given the small sample size (n = 30), the clustering and PCA results should be interpreted as exploratory. Replication with larger samples or across multiple courses would be needed to strengthen the generalisability of these findings.

6 Discussion

Our study provides important insights into students' perceptions of teacher skills and their effects on learning outcomes, both supporting and extending existing research. In particular, the strong association between Listening and Availability and Presentation Clarity (r = 0.78) suggests that students do not perceive clarity as a purely technical skill but as embedded within broader relational competencies. This finding aligns with (Yin, X and all, 2024), who emphasize the role of emotional intelligence and interpersonal engagement in shaping student satisfaction and perceived instructional clarity, as well as with [13–15], who highlight the contribution of attentiveness and responsiveness to cognitive flexibility and learning outcomes.

In the context of Moroccan higher education, these findings suggest that instructors who are accessible and attentive can foster a more effective and supportive learning environment, particularly in specialized fields such as logistics. Our hierarchical clustering analysis, which grouped teacher skills into interpersonal (e.g., trainer effectiveness, listening, availability, motivation) and organizational (e.g., time management, clear learning objectives, session structure) clusters, mirrors the theoretical distinction between affective and cognitive teaching dimensions supported by [13–15] in biology education.

Students integrate relational skills into a domain of foundational competence, facilitating engagement and motivation, while organizational skills provide structural clarity that reduces cognitive load and enhances comprehension. This distinction has practical implications for Moroccan universities, suggesting that teacher training programs should emphasize the simultaneous development of interpersonal and organizational teaching skills to optimize student productivity. The use of the elbow method to identify four optimal clusters of teaching attributes corresponds to methodologies applied in prior educational research [35], providing a robust framework for interpreting complex teaching-skill datasets.

The optimal cluster structure enables clear differentiation of student perceptions, which can inform targeted interventions to improve instructional design and course

delivery. For example, students who value interpersonal engagement can benefit from collaborative and interactive activities, whereas those prioritizing organizational skills may respond better to structured lectures and clear learning objectives. The PCA results, which reveal three distinct clusters of students based on their perceptions of teacher skills, highlight the heterogeneity of learning preferences. Cluster 1 prioritizes interpersonal and engagement skills, Cluster 2 emphasizes organizational and management skills, and Cluster 3 exhibits diverse preferences regarding presentation clarity and engagement. These findings align with [31] and extend insights from [13–15], demonstrating that cognitive flexibility and resilience mediate how students perceive instructional strategies. In Moroccan logistics education, recognizing these differences can guide instructors in adapting their teaching approaches to better meet diverse student needs.

Furthermore, the observed negative correlation between Active Engagement and Presentation Clarity ($r = -0.29$) suggests that highly interactive sessions may, at times, introduce cognitive overload, consistent with the theoretical perspectives of [12]. This underscores the importance of balancing active learning strategies with clear and structured content delivery to prevent student confusion and enhance productivity. Overall, our findings underscore the critical role of interpersonal, organizational, and presentation-related skills in shaping student perceptions of teaching effectiveness. By empirically structuring teaching skills through PCA and clustering, this study provides evidence that well-coordinated relational and organizational competencies collectively enhance student productivity. The results have clear implications for Moroccan higher education: universities should prioritize teacher training programs that cultivate relational engagement, structured session planning, and adaptive teaching strategies to support diverse learning preferences. Our study contributes to the literature by demonstrating that:

- Interpersonal and organizational teaching skills naturally cluster, influencing student engagement and productivity.
- Student perceptions of teacher skills are heterogeneous, highlighting the need for flexible instructional approaches.
- Structured empirical analyses, including PCA and clustering, can provide actionable insights for improving teaching practices.

These findings extend prior research [10]; (Panigrahi et al. 2021) while integrating recent evidence from [13–15], reinforcing the importance of adaptive, relational, and structured teaching strategies in promoting high student productivity within Moroccan higher education.

7 Conclusion

This study provides a structured analysis of the relationships between various teacher skills and student perceptions, offering key empirical insights into how specific teaching attributes influence student engagement and productivity in Moroccan higher education. Using correlation analysis, hierarchical clustering, and PCA, the study identifies distinct clusters of teacher skills, highlighting the critical role of both interpersonal (e.g., availability, motivation) and organizational (e.g., time management, structured sessions) attributes in effective teaching.

The findings show that students value clarity, structured sessions, and relational engagement, while active engagement is perceived as a distinct skill dimension. Recent empirical evidence supports the view that student engagement primarily reflects the instructional strategies adopted by instructors rather than functioning as an isolated teaching skill. For instance, the study by [32, 33] demonstrates that specific pedagogical approaches, such as Project-Based Learning, significantly enhance student engagement by restructuring learning activities around collaboration, autonomy, and problem-solving. The study contributes to existing research by empirically structuring teaching skills through multivariate analysis, linking statistical patterns with educational theory, and providing evidence specific to Moroccan higher education.

This integration of empirical and theoretical insights reinforces the understanding that effective teaching requires a balance of relational, organizational, and instructional competencies.

Implications for teacher development are clear: educational institutions should implement targeted training programs emphasizing interpersonal skills, clarity, and structured session delivery. Teachers can also adopt flexible, student-centered strategies that respond to diverse learning preferences, using the identified skill clusters to tailor instructional approaches and improve engagement and satisfaction as [32, 33] demonstrated that enhancement of teaching skills requires the implementation of structured, evidence-based training programs.

Limitations include the small, context-specific sample, absence of external moderating factors (e.g., institutional support, demographic variables), reliance on quantitative methods and also student productivity is measured through a subjective proxy rather than objective performance indicators such as grades or task completion metrics. While perceived productivity is a meaningful outcome in educational contexts.

Future research should address these limitations by expanding the sample, incorporating qualitative approaches such as interviews or focus groups, and exploring how external factors influence student perceptions of teaching skills. Longitudinal studies could also investigate how student preferences and the effectiveness of teaching strategies evolve over time led to future research should integrate behavioral and academic performance measures to capture productivity more comprehensively.

Author contributions

Zakaria ELKHARMALI conceptualized the study, designed the research methodology, collected and analyzed the data, and drafted the manuscript. Abdelhafid KHAZZAR provided critical review. Yasser LACHHAB provided critical review. Ouail EL KHARRAZ supervised the research and revised the manuscript for intellectual content. Said EL-MARZOUKI revised the manuscript for intellectual content. Kaoutar CHAALI revised the manuscript for intellectual content.

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Data availability

The datasets generated and analysed during the current study are not publicly available due to privacy considerations, but they are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical clearance for the study was obtained at the course and departmental level through the class coordinator. Formal approval from an institutional ethics committee was not required due to the anonymous, voluntary, and non-invasive nature of the survey. All participants provided informed consent to take part in the study.

Consent forpublication

Not applicable.

Competing interests
The authors declare no competing interests.

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