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The influence of learning environment to students' non-cognitive outcomes: Looking through the PISA lens

Nagla Ali [1], Othman Abu Khurma [1*], Ernest Afari [2], Myint Swe Khine [3]

[1] Emirates College for Advanced Education, Abu Dubai, UAE
[2] University of Bahrain, Zallaq, BAHRAIN
[3] Curtin University, Bentley, WA, AUSTRALIA

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Abstract

To examine the relationship between students' perceptions and their non-cognitive outcomes, this research uses secondary analysis of PISA data from 14,167 students in the United Arab Emirates. Seven factors of learning environment were identified after reviewing the literature. The findings reveal that six factors of the learning environments had a statistically significant association with epistemological beliefs. It was also found that three aspects of learning environments had a statistically significant association with self-efficacy. The results indicate that the three aspects of learning environments had a statistically significant association with anxiety. There was no association found between anxiety and any other teacher factors. The findings also show a positive and statistically significant relationship between students' epistemological beliefs and self-efficacy, and a negative significant relationship between self-efficacy and anxiety. The research thus confirmed previous research by establishing a significant association between the nature of the learning environment and students' cognitive outcomes.

Keywords: learning environment, self-efficacy, anxiety, epistemological beliefs

INTRODUCTION

Learning is a complicated processes affected by a number of factors. Learning processes are influenced by students' social and emotional encounters, which eventually impact students learning outcomes (Händel et al., 2020). Cognitive and non-cognitive outcomes of learning are possible. While non-cognitive learning outcomes are referred to as attitudes, actions, and values that contribute to people competencies, cognitive learning outcomes are known as formal knowledge and are the tangible goal of the educational process (Vanbecelaere et al., 2020). Academic achievement is more likely to rise in schools that enhance pupils' learning experiences and aim at enhancing both cognitive and non-cognitive outcomes. Given that many children have been deprived of on social contacts and support from peers and teachers as a result of the COVID-19 pandemic, it is crucial to attend to the interpersonal and emotional needs of both students and teachers (Yorke et al., 2021). In OECD countries, a number of aspects of the learning environment, such as students' growth mindsets, teacher's support and enthusiasm and students' feeling of belonging at school have all been positively linked to improved student learning outcomes (OECD, 2019). Successful teaching and learning are facilitated by a positive psychosocial learning climate. It pertains to the dynamic interaction between the psychological dimensions of students' experiences–their ideas, feelings, and behaviors–and their broader social experiences–their interpersonal connections, social networks within their families and communities, social norms, and cultural practices (Rongen et al., 2020).

Assessment methods such as TIMSS and PISA are only two examples of the many instruments that have been developed in recent years to assess learning outcomes. The Organization for Economic Co-operation and Development (OECD) is in charge of overseeing the administration of the Program for International Student Assessment, more often known as PISA. PISA focuses on assessing the non-cognitive and cognitive abilities of 15-year-olds to see if they are capable of applying what they have learned in the classroom to real-world situations by

✉ nali@ecae.ac.ae ✉ othman.abukhurma@ecae.ac.ae **(*Correspondence)** ✉ eafari@uob.edu.bh ✉ m.khine@curtin.edu.au

Contribution to the literature

- The current study examined six factors of the learning environment and their association with anxiety, epistemological beliefs, and self-efficacy in the UAE.
- The six factors of the learning environment together were not examined before in this literature.
- This study provides substantial interpretation into the current teaching and learning practices in the UAE, and could help in reforming policies to address learners' non-cognitive outcomes.

the time they have finished their obligatory schooling (Agasisti & Zoido, 2018).

United Arab Emirates (UAE) has been participating in PISA since 2009, which results in substantial data on student perception and learning outcomes (MOE, 2018). This study uses PISA 2015 data to explore how students' perceptions of their school's learning environment relate to non-cognitive outcomes including epistemological beliefs, self-efficacy, and anxiety. There is a need to conduct the study in the light of limited investigation conducted in the area in UAE. Only one similar study was found by Khine et al. (2020), which analyzed PISA data from the UAE to examine the associations between students' opinions of their learning settings and their non-cognitive outcomes. The study however did not consider anxiety as a non-cognitive outcome. The study thus fills the gap in the literature by analyzing PISA data in the context of UAE and will as a guidance to policy-makers in UAE to develop and implement appropriate academic policy for the enhancement of learning outcomes.

REVIEW OF THE LITERATURE

Various theories reveal the influence of environmental factors on the learning outcomes of students. Activity theory of learning considers a full work/activity system (including teams, companies, etc.) beyond just one actor. It considers the intricacy of real-life action as well as the context, history, culture, and function of the artifact (Goodnough, 2018). According to environmental learning theory, it is unavoidable to observe, imitate, and mimic other people's behaviors, attitudes, and emotional responses. The idea considers how influences from the environment and the cognitive aspects interact to affect how people learn and behave (Ichsan et al., 2019). The behaviorism learning theory holds that a learner's actions and behaviors are a direct result of their interactions with their environment. It implies that, as opposed to internal factors, external forces are what impact and teach conduct (Clark, 2018). Connectivism learning theory emphasizes on the notion that people develop and learn when they connect with others. This could be relationships between them or relationships with their responsibilities and duties in their life. This theory also reveals the link of learning with external environmental factors (Corbett & Spinello, 2020).

This review of the literature for this study focuses on three areas: Using PISA data for country analysis, learning environments, and non-cognitive learning outcomes. Each of these categories is broken down into subtopics.

PISA Data: Secondary Analysis

PISA is conducted by OCED every three years in which 15 year old students from over 80 countries are assessed on their cognitive and non-cognitive outcomes. The assessment tests are conducted in numerous subjects such as mathematics, science and reading as well as background surveys conducted to assess various aspects of the learning environment and the learning outcomes of the students. In many nations, PISA data are utilized to inform education policy, particularly in grey literature, other than the scholarly journals (Baird et al., 2016) Not much is known about the extent to which the research community has advanced on the basis of PISA data. Using PISA data, two prior studies examined the quantity of scholarly journal publications. Both studies (Domínguez et al., 2012; Lindblad et al., 2015) described features of the types of papers published using PISA data, and one of them focused only on articles that compared different countries (Lindblad et al., 2015).

In order to investigate the connection between students' perceptions of their learning environment and non-cognitive outcomes, Khine et al. (2020) carried out a secondary analysis of the PISA data that was collected from 14,167 students in the UAE (epistemological beliefs, self-efficacy, and attitudes toward science). In another study by Oliver et al. (2021), the authors conducted an examination of 15-year-old pupils' scientific literacy through PISA data in six OECD countries and the correlation of scientific literacy with the teaching methods they encounter. Mammadov and Cimen (2019) utilized student performance and teacher quality data from the 28 nations that took part in PISA 2015 and TALIS 2013 to examine the relative efficacy of each nation and then used a super efficiency model to rank each nation according to its efficacy scores. Gamazo and Martínez-Abad (2020) contend that because PISA has large and reliable databases, many scholars use it as a benchmark when discussing big data in education. The authors examined PISA data to determine which elements at the national, institutional, and individual student levels are most significant in predicting student achievement.

Overall, the papers examined above show the significance of secondary analysis of sizable, existing databases of outstanding quality in education and learning environment research. Another example of the possibilities for secondary analyses using learning environment data is provided in this article.

Learning Environment Factors

Since this paper attempts to examine the relationships between UAE students' perceptions of the learning environment and their non-cognitive outcomes, learning environment studies are reviewed to identify the major factors and how these impact non-cognitive learning outcomes. Extensive studies on learning environment factors (Aluri & Fraser, 2019; Khine et al., 2020; Malik & Rizvi, 2018; Yerdelen & Sungur, 2019) were noted revealing a long list of factors. However, only those factors that have been identified as having an influence on three non-cognitive outcomes–namely epistemological beliefs, self-efficacy, and anxiety–have been selected and will be explored more below.

Cooperation/student cohesiveness

Cooperation and student cohesiveness refers to the way students support each other (Amiryousefi et al., 2019; Fraser, 1998). Positive interpersonal relationships among students are the result of cooperation and student cohesion. This is achieved through a shared sense of identity and support throughout the entire class. Students are found to be better motivated to engage in learning when supported by their peers (Cai et al., 2022). Cooperation and student cohesiveness was found to be positively linked with epistemological beliefs, which are the attitudes about the knowledge and its nature since students gain deeper insights into learning through enhanced cooperation (Yin et al., 2020; Yerdelen & Sungur, 2019). Another positive impact of cooperation and student cohesiveness was found to be on the self-efficacy, which is the confidence in one's capabilities to achieve specific goals (Han et al., 2021; Khine et al., 2020). Cooperation and student cohesiveness was found to be linked with less anxiety of the students since students felt comfort in their groups as noted by McMinn and Aldridge (2020) and Patkin and Greenstein (2020).

Disciplinary climate

The opinions that students have of how consistently the rules are enforced in the classroom and how teachers deal with behavioral issues while classes are in session are referred to as the disciplinary climate (Chi et al., 2018). The learning environment's disciplinary climate is crucial because disruptive behavior in the classroom, which can be controlled by regulations, can cause pupils to miss out on learning opportunities. Disciplinary climate was found to be positively linked with epistemological beliefs since students could focus on their learning and were not disturbed by nuisances in their environment (Chi et al., 2021; Grabau et al., 2021). Another significant impact of disciplinary climate was found to be on the self-efficacy since students were more engaged and interested in their learning resulting in enhanced self-efficacy (Ceylan, 2020; Grabau et al., 2021). Disciplinary climate was found to be linked with less anxiety of the students since students' well-being and comfort is enhanced through clearly established rules as argued by Govorova et al. (2020) and Radišić et al., (2018).

Science laboratory environment

Science laboratory environment is the overall environment of the science laboratory, which affect students' outcomes. The environment is constituted by various components such as student cohesiveness, clarity of rules and resources (Aladejana & Aderibigbe, 2007). Since science is a subject, which needs practical demonstration of the knowledge, the role of science laboratories is established in enhancing students' science outcomes. Science laboratory environment impact students learning and their epistemological beliefs since the environment helped the students develop their beliefs (Peffer & Ramezani, 2019; Rosen & Kelly, 2020). Previous studies also reveal to argue that the students' perceptions regarding science laboratory environment promoted self-efficacy of students regarding science learning (Lee et al., 2020; Wang et al., 2018). Science laboratory environment was found to be linked with lesser anxiety of the students since students' comfort is enhanced through the environmental aspects as argued by Kolil et al. (2020) and Skordi a& Fraser (2019).

Teacher support

A significant factor of learning environment is teacher support. Teachers are expected to facilitate a secure and encouraging learning environment for their pupils, one that encourages their active participation and engagement (Varanasi et al., 2020). A compassionate, active teacher who builds sincere, trustworthy relationships with each student is the foundation of a supportive classroom (Lei et al., 2018). Teacher support was revealed to be positively linked with epistemological beliefs since students were supported by their teachers in achieving deeper understanding and greater insights of knowledge (Maison & Syamsurizal, 2019; Sengul et al., 2020). Self-efficacy was found to be improved through teacher support as teachers are considered as a guiding force, which directs the students towards achieving their goals (Chong et al., 2018; Liu et al., 2021). A key role of teachers is to guide students in managing their anxiety. Positive reinforcement that is not focused on results and is based on praising tiny efforts is one way that teachers might help students feel less anxious (Jin & Dewaele, 2018; Lazarides & Buchholz, 2019).

Teacher strategy

Teaching strategies are the focal point of learning since these direct the ways in which students learn and achieve their objectives. Appropriate teaching methods inspire students, assist them concentrate, organize material for understanding and memory, monitor and evaluate learning, stimulate self-monitoring and self-correction, and provide instruments for reflecting on and evaluating individual learning (Nurhidayat et al., 2021). Teacher strategy was found to be associated with epistemological beliefs since students could enhance their conceptual learning when their teachers adopted appropriate strategy (Sengul et al., 2020). Gok (2018) found that compared to traditional teacher-centered teaching, the think pair share teaching strategy had a greater favorable impact on students' conceptual learning and epistemological beliefs of students. Self-efficacy was found to be improved through teacher strategy as teachers plan the learning according to individual needs enhancing learners self-efficacy (Garner et al., 2018; Teig et al., 2019). Teacher strategy is also noted to reduce student anxiety levels since teachers understand the individual needs of their students and help them manage their issues effectively (Savitsky et al., 2020; Wang et al., 2022).

Teacher feedback

Learning is cyclical process, which requires continuous assessment, reflection and improvement in learning activities. Teacher feedback is a valuable way to inform student about the learning progress and methods to enhance learning (Torres et al., 2020). Teacher feedback was known to be associated with epistemological beliefs since students able to acknowledge their shortcomings, which helped them improve their conceptual learning (Areepattamannil et al., 2020; Rahmiati & Emaliana, 2020). Teacher feedback was noted to positively enhance student self-efficacy as students were informed of their positive and negative points, which helped them develop (Ruegg, 2018; Sokmen, 2021). Students are noted to feel less anxious after using the teachers' feedback in their learning since they apply the teachers' observations (Abdullah et al., 2018; Johnson et al., 2021).

Teacher adaptation

To meet the varying needs of the students, teachers who practice adaptive teaching modify their teaching so that they are suitable for every student in the classroom (Pennings et al., 2018). To help a student attain the desired learning outcomes, adaptation may involve changing the teaching method, the instructional materials, the assignments, or the student-produced products. Epistemological beliefs are affected by teacher adaptation since teachers' adapting to the varying needs of students enable them to have deeper conceptual learning (Gunes & Bati, 2018; Sengul et al., 2020). Another impact of teacher adaptation was found to be on student self-efficacy as teachers' adaptability resulted in enhanced learning, which consequently improved students' belief in their capabilities (Gardner et al., 2019; Walsh et al., 2020). As teachers become more considerate of students needs and become adaptable, this also results in less anxiousness amongst students (Jin, 2022; Wang et al., 2021).

Non-Cognitive Outcomes

Non-cognitive outcomes have been receiving attention as major learning outcomes recently as these affect the performance of individuals in their practical life (Choi et al., 2022). Although there are a number of non-cognitive outcomes, we chose three non-cognitive outcomes to be investigated in the current study i.e. students' epistemological beliefs, self-efficacy, and anxiety.

Epistemological beliefs

An individual's ideas regarding the way knowledge is acquired, how it is used, and how they affect learning are known as epistemological beliefs (Schommer, 2019). It has been discovered that a person's epistemological views are crucial for both intellectual growth and subject-specific learning. According to Lee et al. (2022), students' epistemological views, which are influenced by the learning environment they are exposed to, have an impact on their learning outcomes. High levels of epistemological beliefs (such as the idea that knowledge is simple and exact as well as being capable of knowing everything) are noted to results in lesser anxiety of students since they become more certain about the nature of knowledge and its applicability (Fetterly, 2020; Karakolidis et al., 2019). High levels of epistemological beliefs are also noted to positively impact students' self-efficacy since they become more confident in their abilities and knowledge to conquer life challenges (Ucar, 2018). On the other hand, low levels of epistemological beliefs impact students' confidence and thus self-efficacy. Research has demonstrated that although learning can be a complicated process, students' epistemological beliefs can predict their attitudes and have a favorable impact on their self-efficacy (Canpolat, 2019). Furthermore, Ashrafzade et al. (2019) argue that epistemological beliefs affect self-efficacy resulting in the impact of performance of students. The PISA 2015 background questionnaire contains the six questions that measure students' epistemic beliefs and are also used in this secondary analysis.

Self-efficacy

A person's self-efficacy refers to the confidence an individual has in their ability to take the necessary actions to achieve particular goals and thus alludes to a

person's trust in his capabilities (Gielnik et al., 2020). When an individual has higher levels of confidence in his capabilities and knowledge, his outlook and responses to the social environment is improved. Tahmassian and Moghadam (2011) argue that self-efficacy has negative link with anxiety since people feel more confident in their capabilities when their self-efficacy levels are high. Rabei et al. (2020) note that future anxiety of students is significantly related to their self-efficacy since the students become more anxious if they are less confident in their capabilities. Student achievement has been linked to students' self-efficacy beliefs as the self-efficacy reduces the negative forces, which might hinder student performances. Five items were used from PISA questionnaire items to evaluate the self-efficacy in the present study.

Anxiety

A feeling of unease, such as concern or fear is referred to as anxiety. It is a psychological feeling, which can be felt by anyone at any time and can be mild to severe. Because anxiety affects people's life events and results, it has negative influence on cognitive function and contributes to psychological, social, and economic consequences (Yang & Quadir, 2018). A large part of a person's mental capacity is required to generate and analyze ideas when they are anxious. This can make it very difficult for the student to concentrate on learning, which negatively impacts their learning outcomes (Stormon et al., 2019). Students' anxiety is noted to be affected by a number of factors. For example, students' epistemological beliefs that science knowledge is constantly changing makes science students more nervous as compared to the opposing belief (Lin et al., 2013). Five PISA 2015 background questionnaire items were utilized in the current paper to investigate anxiety.

The literature review reveals that previous studies established the use of PISA data to assess education practices in different countries and inform educational policies. The review also confirmed the role of learning environment factors on various cognitive and non-cognitive learning outcomes as well as the use of PISA data to investigate the same. However, there was a gap found in the context of UAE since limited studies were found, which explored PISA data about UAE students to assess the relationships between students' perceptions of their learning environments and their non-cognitive outcomes. As a result, a gap was found in the existing literature, and the purpose of this study is to try to fill it by analyzing the PISA data collected on the UAE in order to investigate the relationship that exist between students' perceptions of their learning environments and the non-cognitive outcomes (epistemology beliefs, self-efficacy, and anxiety).

RESEARCH MODEL

Figure 1 presents the conceptual framework of our investigation. These theories are grounded in the ideas and studies discussed in the literature review section, as well as the corresponding hypotheses. Each of the seven aforementioned psychosocial characteristics of the learning outcomes will have a significant bearing on students' non-cognitive results (epistemological beliefs, self-efficacy, and anxiety). In addition, it is hypothesized that self-efficacy and anxiety are strongly connected with epistemological beliefs and that the inverse is also true. The following hypotheses were tested throughout this study:

1. **Hypotheses 1 (H1):** There is statistically significant relationships between cooperation/students' cohesiveness and epistemological beliefs.
2. **Hypotheses 2 (H2):** There is statistically significant relationships between cooperation/students' cohesiveness and self-efficacy.
3. **Hypotheses 3 (H3):** There is statistically significant relationships between cooperation/students' cohesiveness and anxiety.
4. **Hypotheses 4 (H4):** There is statistically significant relationships between disciplinary climate and epistemological beliefs.
5. **Hypotheses 5 (H5):** There is statistically significant relationships between disciplinary climate and self-efficacy.
6. **Hypotheses 6 (H6):** There is statistically significant relationships between disciplinary climate and anxiety.
7. **Hypotheses 7 (H7):** There is statistically significant relationships between science laboratory environment and epistemological beliefs.
8. **Hypotheses 8 (H8):** There is statistically significant relationships between science laboratory environment and self-efficacy.
9. **Hypotheses 9 (H9):** There is statistically significant relationships between science laboratory environment and anxiety.
10. **Hypotheses 10 (H10):** There is statistically significant relationships between teacher support and epistemological beliefs.
11. **Hypotheses 11 (H11):** There is statistically significant relationships between teacher support and self-efficacy.
12. **Hypotheses 12 (H12):** There is statistically significant relationships between teacher support and anxiety.

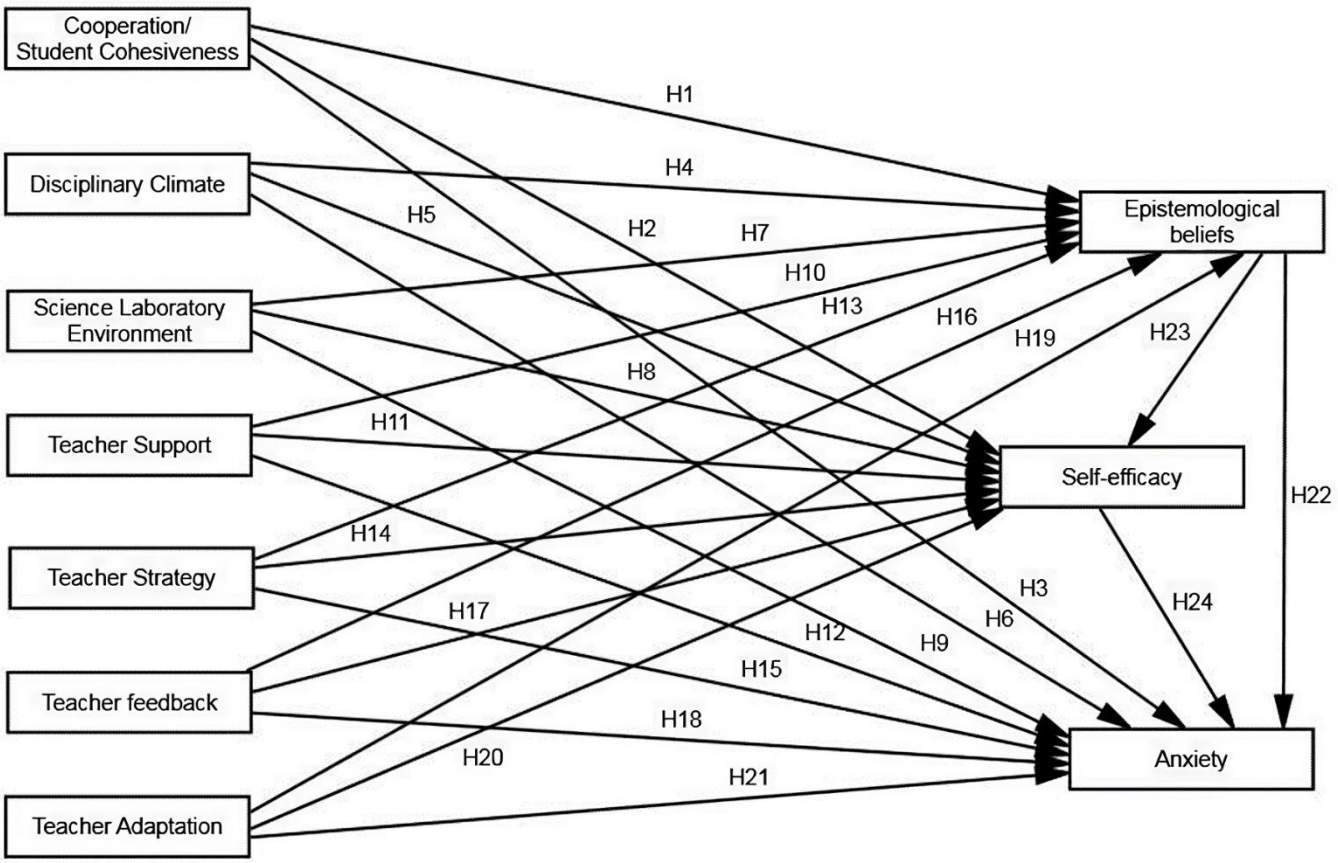

Figure 1. Research model (Khine et al., 2020)

13. **Hypotheses 13 (H13):** There is statistically significant relationships between teacher strategy and epistemological beliefs.
14. **Hypotheses 14 (H14):** There is statistically significant relationships between teacher strategy and self-efficacy.
15. **Hypotheses 15 (H15):** There is statistically significant relationships between teacher strategy and anxiety.
16. **Hypotheses 16 (H16):** There is statistically significant relationships between teacher feedback and epistemological beliefs.
17. **Hypotheses 17 (H17):** There is statistically significant relationships between teacher feedback and self-efficacy.
18. **Hypotheses 18 (H18):** There is statistically significant relationships between teacher feedback and anxiety.
19. **Hypotheses 19 (H19):** There is statistically significant relationships between teacher adaptation and epistemological beliefs.
20. **Hypotheses 20 (H20):** There is statistically significant relationships between teacher adaptation and self-efficacy.
21. **Hypotheses 21 (H21):** There is statistically significant relationships between teacher adaptation and anxiety.
22. **Hypotheses 22 & 23 (H22 & H23):** There is a statistically significant correlation between self-efficacy and anxiety and epistemological beliefs.
23. **Hypotheses 24 (H24):** Self-efficacy statistically significantly associated with anxiety.

Participants

The data obtained from the PISA 2015 examination was employed for the purposes of this study. PISA, 2015 was taken by 14,167 students from 481 schools located all over the UAE. There were 7,052 male participants and 7,115 female participants. Because of the encouragement provided by the government, there were four times as many people from the UAE who participated as it is required by law. The UAE has set a lofty goal for itself: to be among the top 20 nations on the PISA. The purpose of PISA is to evaluate students' knowledge and abilities in reading, mathematics, science, and problem-solving at the age of 15. It also produces background scores based on sets of questionnaire items that are designed to gauge students' attitudes about learning and their learning environment. These scores are generated based on the data collected from the students. These worldwide evaluations try to give decision-makers information on the quality of education by comparing student performance to that of peers in participating nations, as well as by identifying major school- and student-level characteristics associated with achievement.

Table 1. Description & sample item for each scale

Code	Scale	Number of items	Sample item
CSC	Cooperation/student cohesiveness	8	I enjoy cooperating with peers.
DCL	Disciplinary climate	5	There are noise & disorder.
SLE	Science laboratory environment	9	Students are asked to do an investigation to test ideas.
TSP	Teacher support	5	Teacher gives extra help when students need it.
TST	Teacher strategy	4	A whole class discussion takes place with teacher.
TFB	Teacher feedback	5	Teacher tells me in which areas I can improve.
TAD	Teacher adaptation	3	Teacher adapts the lesson to my class's needs & knowledge.
ANX	Anxiety	5	Even if I am well prepared for a test I feel very anxious.
SEF	Self-efficacy	5	I see myself as an ambitious person.
EFB	Epistemological beliefs	6	A good way to know if something is true is to experiment.

Table 2. Scale mean scores & standard deviation of UAE students who participated in PISA 2015

Construct	Mean	Standard deviation	Skewness	Kurtosis
Cooperation/student cohesiveness	3.18	0.48	-0.10	0.31
Disciplinary climate	2.91	0.77	-0.13	-0.02
Science laboratory environment	2.43	0.72	-0.02	-0.05
Teacher support	1.77	0.78	0.18	0.02
Teacher strategy	2.79	0.80	-0.06	-0.15
Teacher feedback	2.45	0.82	0.04	-0.13
Teacher adaptation	2.56	0.80	0.05	-0.21
Anxiety	2.72	0.65	-0.05	0.03
Self-efficacy	3.51	0.54	-0.30	0.68
Epistemological beliefs	3.05	0.60	-0.19	0.39

Instrument

The following scales were obtained from the PISA 2015 database for the UAE because of possible single and/or joint associates with students' perceptions of the learning environment, epistemological beliefs, self-efficacy, and anxiety: cooperation/tudent cohesiveness (based on eight items), disciplinary climate (five items), science laboratory environment (nine items), teacher support (five items), teacher strategy (four items), teacher feedback (five items), teacher adaptation (three items), epistemological beliefs (six items), self-efficacy (five items) and anxiety (five items). Both the scales and the items used to create them are shown in **Table 1**.

These items were developed by OECD and rigorously tested and reported the reliability measures in the technical report. PISA computed these scales (WARM estimates) and set them to an international mean of approximately zero, and an international standard deviation of one (OECD, 2017).

Evaluation of normality assumptions

Means, standard deviations, skewness, and kurtosis were calculated across all scales to test the normality assumption (**Table 2**).

The mean values and standard deviations ranged from 0.48 to 0.82 and 1.77 to 3.18, respectively, indicating that the responses were very equally distributed around the mean. The univariate normality of the data was assessed using skewness and kurtosis indices, which varied from -0.02 to 0.05 and -0.05 to 0.68, respectively. According to Kline's (2011) recommendation that the skewness and kurtosis indices should not be more than |3| and |10|, respectively, the data in this study were declared normal and eligible for further analyses.

Missing data

Scales for the study consisted of 55 items with 100% incomplete data in the variables, 5,704 (40.26%) missing cases, and 88,558 (11.37%) missing values. Items for which data was not received were categorized as non-response items. Item nonresponse, as defined by Graham (2012, p. 4), occurs when a respondent answer most of the questions in a survey and skips over others. In this analysis, missing data were handled by employing Multiple Imputation (Rubin, 1996).

Multiple imputation approaches were used to examine the missing data patterns, and the results confirmed that the patterns were completely random. Five distinct data sets were produced, each with a unique set of imputations (Schafer & Graham, 2002). All the imputed data sets' parameter values were combined for statistical testing, leading to more precise estimates than would have been possible with a single imputation (Graham, 2012).

Convergent and discriminant validities

Analysis of moment structure (AMOS) version 22 was used for the confirmatory factor analysis that assessed the measurement properties (Arbuckle, 2010). For this study, we analyzed the convergent and discriminant validity indices of the 55-item instrument.

Table 3. Bivariate correlations among the constructs (n=14,167)

	CSC	DCL	SLE	TSP	TST	TFB	TAD	ANX	SEF	EPB
CSC	**(.71)**									
DCL	.15**	**(.82)**								
SLE	-.17**	-.12**	**(.71)**							
TSP	-.18**	-.24**	.51**	**(.79)**						
TST	.20**	.28**	-.29**	-.43**	**(.76)**					
TFB	.21**	.21**	-.38**	-.41**	.48**	**(.82)**				
TAD	.20**	.26**	-.34**	-.48**	.55**	.58**	**(.71)**			
ANX	.06**	-.07**	.04**	.05**	-.04**	-.04**	-.05**	**(.73)**		
SEF	.35**	.08**	-.05**	-.12**	.16**	.13**	.14**	.11**	**(.77)**	
EPB	.17**	.17**	-.00	-.11**	.23**	.14**	.25**	-.01	.20**	**(.71)**

Note. **p<.01; Off-diagonals: Correlations between constructs; & Diagonal in parentheses & **bold**: $\sqrt{AVE}$

To examine the convergent validity of the measuring items, Fornell and Larcker (1981) advised examining the item reliability, the composite reliability of each construct, and the average variance extracted. Factor loadings ranged from.58 to.90 (**Appendix A**), all above.50, indicating that all factors in the measurement model are appropriate (Hair et al., 1992). Composite reliability ratings more than or equal to .70 indicate sufficient reliability, as stated by Nunnally and Bernstein (1994).

Table 3 shows that the composite reliability for each building type ranged from .76 to .90. Finally, the AVE of each construct was analyzed as a criterion for convergent validity. All the items' AVEs (also presented in **Appendix A**) were all more than .50, indicating that more than half of the variance in the constructs could be attributed to the predicted causes. All three criterion for convergent validity were thus met by the measurement quality.

The presence of discriminant validity, according to Teo (2010), is shown when the variance shared by a construct and all other constructs in the model is less than the variance shared by constructs with their indicators. The supplied construct has a stronger relationship to its indicators than the other constructs in the model if the square roots of the AVEs are larger than the off-diagonal elements of the corresponding rows and columns (Teo, 2009). The values in the matrix diagonals (which reflect the square roots of the average variance recovered) are bigger than the off-diagonal components in their associated rows and columns, hence the ten-factor model with 55 items displayed discriminant validity (see **Table 3** for details).

Data Analysis

A confirmatory factor analysis (CFA) was undertaken using AMOS version 22 to ensure the validity and reliability of the suggested model (Arbuckle, 2010). There was an examination of both the CR and the IR of each construct's items. Average variance extracted (AVE) was used to test convergent validity, while square root of AVE was used to test discriminant validity, both for each component in the measurement model.

Using structural equation modelling (SEM) and maximum likelihood estimation, we looked into the connections between the variables. Multiple fit indices were used to evaluate the quality of the model fit, as recommended by Kline (2011). These indices each revealed unique information about the quality of the model fit (Harrington, 2009). Consequently, we presented a variety of fit indices to evaluate the quality of the offered model. Kline (2011) proposed the following guidelines for a "acceptable" model fit: RMSEA stands for root mean square approximation error. RMSEA.05 indicates a good fit,.05.08 indicates a moderate approximation error, and.10 indicates a very poor fit. When the CFI (comparative fit index) and TLI (Tucker-Lewis' Index) are greater than.90, it indicates that the data fits the researcher's model very well. Model chi-square, root mean squared error of approximation (RMSEA), and the RMSEA 90% confidence interval are all recommended by Kline (2011).

RESULTS

Test of the Measurement Model

The structural equation modeling approach was used in conjunction with the computer application AMOS 22 to conduct the study's hypothesis tests (Arbuckle, 2010). Earlier in the analysis, we noted that various indices, including (TLI=92; CFI=.93; RMSEA=.042 [.041, .042]), were within Kline (2011)'s recommended ranges.

Test of the Structural Model

A test of the structural model demonstrated a good model fit (TLI=0.91, CFI=0.92, RMSEA=0.037 [0.036, 0.037]). **Table 4** displays the results of the hypothesis test and the route coefficients for the proposed research model. The findings suggested that fifteen of twenty-four hypotheses were supported by the data.

Three endogenous variables were investigated using the research model. Epistemological beliefs were predicted by cooperation/student cohesiveness,

Table 4. Hypothesis testing results

Hypotheses	Path	Path coefficient	t	Results
H1	Cooperation/student cohesiveness → Epistemological beliefs	.13***	12.35	Supported
H2	Cooperation/student cohesiveness → Self-efficacy	.38***	35.35	Supported
H3	Cooperation/student cohesiveness → Anxiety	-.07***	5.88	Supported
H4	Disciplinary climate → Epistemological beliefs	.09***	8.67	Supported
H5	Disciplinary climate → Self-efficacy	-.02	-1.47	Not supported
H6	Disciplinary climate → Anxiety	-.08***	-6.25	Supported
H7	Science laboratory environment → Epistemological beliefs	.15***	11.92	Supported
H8	Science laboratory environment → Self-efficacy	.07***	6.06	Supported
H9	Science laboratory environment → Anxiety	-.03*	2.38	Supported
H10	Teacher support → Epistemological beliefs	.03	1.88	Not supported
H11	Teacher support → Self-efficacy	04**	2.87	Supported
H12	Teacher support → Anxiety	-.03	-1.71	Not Supported
H13	Teacher strategy → Epistemological beliefs	.11***	7.50	Supported
H14	Teacher strategy → Self-efficacy	.06	4.26***	Supported
H15	Teacher strategy → Anxiety	-.00	.84	Not supported
H16	Teacher feedback → Epistemological beliefs	-.09***	-6.32	Supported
H17	Teacher feedback → Self-efficacy	.00	.17	Not supported
H18	Teacher feedback → Anxiety	-.01	-.33	Not supported
H19	Teacher adaptation → Epistemological beliefs	.31***	16.41	Supported
H20	Teacher adaptation → Self-efficacy	.00	.15	Not supported
H21	Teacher adaptation → Anxiety	-.04	-1.88	Not supported
H22	Epistemological beliefs → Anxiety	-.02	-1.23	Not supported
H23	Epistemological beliefs → Self-efficacy	.17***	15.67	Supported
H24	Self-efficacy → Anxiety	-16***	-.13.13	Supported

disciplinary climate, science laboratory environment, teacher strategy, teacher feedback, and teacher adaptation, resulting in an R^2 of .16, which explains 16% of the variance in epistemological beliefs. Students' perceptions of cooperation/student cohesiveness (β=.13, p<.001), disciplinary climate (β=.09, p<.001), science laboratory environment (β=.15, p<.001), teacher strategy (β=11, p<.001), teacher feedback (β=-.09, p<.001), and teacher adaptation (β=.31, p<.001) were related to epistemological beliefs. The variance in the other two endogenous variables, self-efficacy and anxiety, was explained by their antecedents at 22% and 4.6%, respectively. Students' perceptions of teacher support (β=-.04, p<.01), cooperation/student cohesiveness (β=.38, p<.001), science laboratory environment (β=.07, p<.001), and teacher strategy (β=.06, p<.001) were related to self-efficacy. Also, students' perceptions of cooperation/student cohesiveness (β=-.07, p<.001), discipline climate (β=-.07, p<.001), and science laboratory environment (β=-.03, p<.05) were associated with anxiety. **Table 4** displays the results of the hypothesis testing and the path coefficients.

DISCUSSION

This study used a secondary analysis of PISA 2015 data to investigate the relationships between students' perceptions of the learning environment and their noncognitive outcomes (such as, self-efficacy, epistemological beliefs, and anxiety). After researching the literature, seven factors of the learning environment were identified: cooperation/student cohesion, disciplinary atmosphere, science laboratory environment, teacher support, teacher strategy, teacher feedback, and teacher adaptation. Seven learning environment components and three non-cognitive outcomes were hypothesized to be related by twenty-four hypotheses.

Cooperation/student cohesion was found to significantly correlate with epistemological beliefs, self-efficacy, and anxiety, all of which are non-cognitive outcomes (**H1**, **H2**, and **H3**). Yerdelen and Sungur (2019) and Yin et al. (2020) supported the findings and argued that cooperation and student cohesiveness was found to be positively linked with epistemological beliefs. Similarly, Han et al. (2021) and Khine et al. (2020) revealed that cooperation/student cohesiveness led to improved self-efficacy as also confirmed by this study. Significant negative correlation between cooperation/student cohesiveness and anxiety is supported by McMinn and Aldridge (2020) and Patkin and Greenstein (2020).

Significant association between disciplinary climate and epistemological beliefs (**H4**) was found from the study as also corroborated by Chi et al. (2021) and Grabau et al. (2021). No significant relationship was found between disciplinary climate and self-efficacy (**H5**) as opposed to Ceylan (2020) and Grabau et al. (2021) and between disciplinary climate and anxiety (**H6**) as contradictory to Govorova et al. (2020) and Radišić et al., (2018).

The study found significant relationship between science laboratory environment and epistemological

beliefs (**H7**), self-efficacy (**H8**), and anxiety (**H9**). These findings are supported by Peffer and Ramezani (2019) Rosen and Kelly (2020) for epistemological beliefs; Lee et al. (2020) and Wang et al. (2018) for self-efficacy and Kolil et al. (2020) and Skordi and Fraser (2019) for anxiety.

This analysis did not find significant link between teacher support and epistemological beliefs (**H10**). This contradicts Maison and Syamsurizal (2019) and Sengul et al. (2020) who argue that students when supported by their teachers in achieve deeper conceptual learning. Teacher support and self-efficacy (**H11**) was found to be significantly linked as also confirmed by Chong et al. (2018) and Liu et al. (2021). The study could not reveal link between teacher support and anxiety (**H12**), which is opposed by Jin and Dewaele (2018) and Lazarides and Buchholz (2019) who argue that teachers support reduces anxiety levels of students.

Significant association was found between teacher strategy and epistemological beliefs (**H13**) and self-efficacy (**H14**) as also supported by Gok (2018) and Sengul et al. (2020) for epistemological beliefs and Garner et al. (2018) and Teig et al. (2019) for self-efficacy. No significant association was revealed between teacher strategy and anxiety (**H15**) as opposed to Savitsky et al. (2020) and Wang et al. (2022) who argue that since teachers are aware of each student's unique needs and assist them in properly resolving them, they help students' anxiety levels.

The relationship between teacher feedback was found to be significant with epistemological beliefs (**H16**), which is supported by Areepattamannil et al. (2020) and Rahmiati and Emaliana (2020). No significant association was revealed between teacher feedback and self-efficacy (**H17**) and anxiety (**H18**). This finding is refuted by Ruegg (2018) and Sokmen (2021) who contend that student self-efficacy is positively impacted by instructor evaluation since students were made aware of both their strengths and weaknesses, which aided in their personal growth. Similarly, Abdullah et al. (2018) and Johnson et al. (2021) disagree with the findings, claiming that students experience less anxiety after applying the professors' observations to their learning.

Teacher adaptation was found to be significant with epistemological beliefs (**H19**), which is supported by Gunes and Bati (2018) and Sengul et al. (2020). No significant association was revealed between teacher adaptation and self-efficacy (**H20**) as contradicted by Gardner et al. (2019) and Walsh et al. (2020) who argue that due to teachers' adaptability, learning was improved, which in turn raised students' self-efficacy. Furthermore, no significant relationship was found between teacher adaptation and anxiety (**H21**) as contradicted by Jin (2022) and Wang et al. (2021) since they argue that less anxiety among students is a result of teachers becoming more flexible and mindful of students' needs.

The relationship between epistemological beliefs and anxiety (**H22**) was not found to be significant from this analysis. This was contradicted by Fetterly (2020) and Karakolidis et al. (2019) who argue that students who have strong epistemological beliefs report less worry because they are clearer about the nature of knowledge and its relevance. The relationship between epistemological beliefs and self-efficacy were found to be significant (**H23**) as supported by Ashrafzade et al. (2019), Canpolat (2019), and Ucar (2018) who argue that epistemological beliefs largely affect students' comprehension of the learning task and the knowledge that has to be obtained, which in turn increases their self-efficacy. The relationship between self-efficacy and anxiety (**H24**) was found to be significant as supported by Tahmassian and Moghadam (2011) and Rabei et al. (2020).

It is thus concluded that majority of the learning environment factors has impact on non-cognitive learning outcomes and thus must be addressed by practitioners.

SUMMARY AND CONCLUSION

This study investigated the relationship between learning environments and epistemological beliefs, self-efficacy, and anxiety. Using the data from PISA 2015, confirmatory factor analysis and structural equation modelling supported the construct validity of the student questionnaires for UAE students. The findings confirm that the six factors of the learning environments (cooperation/student cohesiveness, disciplinary climate, science laboratory environment, teacher strategy, teacher feedback, and teacher adaptation) had a statistically significant association with epistemological beliefs.

It was also found that three aspects of learning environments (cooperation/student cohesiveness, science laboratory environment, and teacher support) had a statistically significant association with self-efficacy. The results indicate that the student's perception of the learning environments (cooperation/student cohesiveness, disciplinary climate, and science laboratory environment) had a statistically significant association with anxiety. All other teacher factors, teacher support, teacher strategy, and teacher feedback had no correlations with anxiety. The results also indicate that students' epistemological beliefs had a positively and statistically significant association with self-efficacy and correspondingly self-efficacy had a negatively significant association with anxiety.

This study is significant because the data utilized in this study are taken from a large-scale assessment involving 72 countries and representing 29 million students. The background questionnaire comprises students' beliefs of their learning environment,

perceptions toward science, epistemological beliefs, self-efficacy, and anxiety. The results from this study can be extended to other countries that participated in the test. Further analysis can be conducted to explore the similarities and differences in learning environments by comparing high and low-performing countries.

Our findings replicate previous learning environment research such as a study by Fraser (2015) that reported a significant association between the nature of the learning environment and students' cognitive outcomes. Also, a study by Pamuk et al. (2017) conducted a multilevel analysis of students' science outcomes in comparison with their epistemological beliefs and learning environment attitudes. They found that students' beliefs of the learning environment, epistemological beliefs, and science outcome scores were associated positively. Since our research studied only 15 years old students who participated in the PISA 2015 test, generalizing the findings should be made with caution. Also, the lack of achievement outcomes is a limitation. So, it will also be interesting to explore a step further to find out the associations between learning environment, teacher factors, and attitudes towards science and students' performance in the PISA test. There will be numerous opportunities to investigate how the students' perceptions of specific aspects of the learning environment interact with epistemological beliefs and influence the learning outcomes. The results can be consulted to improve the classroom learning environment, which can impact the students' achievement.

The study provides significant insights into the existing UAE educational practices and allows to revise policies to improve non-cognitive outcomes of students. It is recommended that educational institutes are encouraged to enhance cooperation and student cohesiveness by designing initiatives. Disciplinary climate needs to be clarified and well-communicated along with science laboratory environment since these are expected to enhance epistemological beliefs leading to better self-efficacy as well as reduced anxiety. It is also recommended that teachers should be given training to devise appropriate strategies, to adapt their teaching in response to the learners needs and to welcome feedback since these lead to epistemological beliefs.

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APPENDIX A

Table A1. Factor loadings, average variance extracted, & composite reliability

Latent variable	Item	Factor loading	AVE	CR
Cooperation/student cohesiveness	ST082Q01NA	.62	.51	.89
	ST082Q02NA	.58		
	ST082Q03NA	.75		
	ST082Q08NA	.64		
	ST082Q09NA	.79		
	ST082Q12NA	.68		
	ST082Q13NA	.86		
	ST082Q14NA	.76		
Disciplinary climate	ST097Q01TA	.76	.60	.88
	ST097Q02TA	.83		
	ST097Q03TA	.81		
	ST097Q04TA	.71		
	ST097Q05TA	.77		
Science laboratory environment	ST098Q01TA	.68	.51	.90
	ST098Q02TA	.70		
	ST098Q03NA	.72		
	ST098Q05TA	.74		
	ST098Q06TA	.69		
	ST098Q07TA	.73		
	ST098Q08NA	.77		
	ST098Q09TA	.65		
	ST098Q10NA	.74		
Teacher support	ST100Q01TA	.72	.62	.89
	ST100Q02TA	.83		
	ST100Q03TA	.90		
	ST100Q04TA	.81		
	ST100Q05TA	.66		
Teacher strategy	ST103Q01NA	.71	.62	.89
	ST103Q03NA	.73		
	ST103Q08NA	.84		
	ST103Q11NA	.81		
Teacher feedback	ST104Q01NA	.63	.60	.88
	ST104Q02NA	.76		
	ST104Q03NA	.86		
	ST104Q04NA	.83		
	ST104Q05NA	.76		
Teacher adaptation	ST107Q01NA	.71	.51	.76
	ST107Q02NA	.69		
	ST107Q03NA	.74		
Anxiety	ST118Q01NA	.68	.50	.83
	ST118Q02NA	.67		
	ST118Q03NA	.76		
	ST118Q04NA	.63		
	ST118Q05NA	.77		
Self-efficacy	ST119Q01NA	.74	.53	.85
	ST119Q02NA	.71		
	ST119Q03NA	.78		
	ST119Q04NA	.65		
	ST119Q05NA	.75		
Epistemological beliefs	ST131Q01NA	.68	.53	.87
	ST131Q03NA	.77		
	ST131Q04NA	.76		
	ST131Q06NA	.75		
	ST131Q08NA	.73		
	ST131Q11NA	.69		