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Inquiry skills teaching and its relationship with UAE secondary school students' critical thinking: Systematic review of science teachers' perspectives

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Abstract

Undoubtedly, due to continuous changes in time, environment, and demand, teaching techniques in science education should be constantly explored, reflected upon, and improved. This paper explores the current evidence related to secondary science teachers' perspectives about teaching inquiry skills in the United Arab Emirates (UAE). After a systematic Boolean search in online databases, a research synthesis was conducted on the perspectives of secondary science teachers regarding inquiry and critical thinking of students in the context of UAE. Eight quantitative and qualitative studies were analyzed, and results showed that science teachers' perspectives on teaching inquiry skills varied across studies. Additionally, some factors should be addressed when teaching critical thinking including socio-psycho factors (e.g., attitudes towards learning science, teacher competence, professional development, student characteristics, teaching and learning practices, and classroom management). This study recommends that further attention should be paid to teaching theories and approaches such as active learning strategy, sociocultural theory, constructivism theory, and affective filter hypothesis. These results are important since they identify the need of reevaluation of inquiry-based teaching and learning of science (e.g., critical thinking skill as a key one) in UAE secondary schools.

Keywords: critical thinking, inquiry-based teaching, science education, secondary education, systematic literature review, teachers' perspectives

INTRODUCTION

Education transformation has been one of the highest priorities on the United Arab Emirates (UAE) national development agenda under its visionary leadership since 1971 (Kouki & Al Shemaili, 2022). As part of its vision, UAE's Ministry of Education, has established aspiring goals to promote innovative, inclusive, and sustainable growth of science education (Ministry of Education [MoE], 2020). In the discourse of previous and current education reforms, "inquiry" has emerged as a constant and crucial concept (Helfenbein, 2021; Tao & Zhang, 2021). Inquiry-based learning enables students to develop "key scientific ideas", promotes their investigation skills, and increases their knowledge and understanding of the world around them. Fostering inquiry-based learning equips students with "skills employed by scientists such as raising questions, collecting data, reasoning and reviewing evidence in the light of what is already known, drawing conclusions, and discussing results" (Jawad et al., 2021; Ogegbo & Ramnarain, 2022). Due to this understanding of inquiry, it is more comprehensive than practical work in which students examine and/or manipulate variables (Agustian et al., 2022; Rumalolas et al., 2021).

Bybee (1993) argues that teachers are the "change agents" who mold the nature of classroom teaching and learning as well as curriculum implementation and education reform initiatives. This shows that the entire process of curricular transformation is weakened and could ultimately fail if teachers do not address curricular innovations in their practice. The individual science teacher who bears the greatest responsibility for classroom decisions and how these decisions relate to curricular reform. Understanding teachers' perspectives about an innovation in the science curriculum could, in turn, boost the likelihood that such an innovation would be implemented successfully (Papadakis et al., 2021; Prasetyono et al., 2021; Roehrig & Kruse, 2005). It is indeed critical to explore science teachers' perspectives

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Contribution to the literature

- This research makes a substantial contribution to science education literature by where the findings highlight varied perspectives among teachers and identify socio-psycho factors influencing this relationship, including attitudes toward learning science, teacher competence, and classroom management.
- These insights fill a crucial gap in understanding effective science teaching practices in UAE secondary schools, particularly in developing 21st-century skills such as critical thinking.

about teaching inquiry skills to secondary students for the purpose of spreading great practice and facilitating collective problem-solving related to teaching challenges (Mansour, 2015).

Even though inquiry-based learning is strongly emphasized in the curriculum, implementation varies among educational environments, according to recent international research (Fan, 2022; Haatainen & Aksela, 2021). Educational change depends on a variety of factors, including the resources available in the classroom, the educational and cultural backgrounds of the students and teachers, the school's culture, the size of the class, and epistemological beliefs (Areepattamannil et al., 2023; Chin & Chia, 2006; Zion et al., 2007).

Teachers are encouraged to engage in reflective practice, share experiences and learning goals as part of planned professional learning. This type of collaborative reflection results in fresh insights and adaptable classroom activities (Kuhaupt, 2019; Sam, 2018). In the last decade, schools in UAE have implemented numerous projects to modernize pedagogic practices and maximize student learning. These advances are founded upon constructivist and cognitive psychology learning theories, which are believed to contribute to "strong learning environments" and facilitate contemporary education. The fundamental objectives of contemporary education are to acquire high-quality knowledge, problem-solving abilities, self-directed learning abilities, and transferable knowledge and skills. Such learning environments are intentionally designed to accomplish these objectives (Kuznetcova & Glassman, 2020; Seufert et al., 2019; Shafait et al., 2021; Xue et al., 2021).

Although the advantages of teaching inquiry skills are becoming clearer and are quite evident in the literature, there are still several barriers preventing their inclusion in teaching practices (McCowan, 2018). The most impeding challenge is the amount of time required for inquiry-based teaching and learning. Every teacher is conscious of the limited amount of time they have with their students; therefore, they must carefully plan how to spend this time efficiently enough to achieve the lesson objectives. This brings up the age-old debate between emphasizing skill development and inquiry while concentrating on a smaller number of topics and covering as much content as feasible. These major alterations require the instructor to dedicate a substantial amount of planning time and, in many instances, to make major class scheduling changes (e.g., Crogman et al., 2015). Other initiatives to highlight learning process abilities have focused on integrating them into lab and research settings; however, not all courses and teachers have access to these resources (e.g., DebBurman, 2002; Kramer, 2018; Voorhees et al., 2022).

A wealth of common information supports the recent trend to raise the cognitive requirements for teaching science inquiry abilities. Incorporating artistic, technical, and creative elements into science learning and teaching methodologies has been one of the innovative pedagogic approaches, especially when tying these skills to other academic disciplines and cultural contexts. Research, theory, and practice in teaching and learning have all been significantly influenced by cognitive psychology, which has inspired designs for technology-mediated teaching and learning environments (e.g., Ali et al., 2023; Koenig & Atkinson, 2009; Sweller et al., 1998).

Due to changes in time, environment, and need, teaching students inquiry skills require teachers to make additional effort while considering the extent of planning, fostering critical thinking (Abu Khurma et al., 2022), differentiation for diverse students, and other related considerations. Therefore, the purpose of this study is to systematically review related studies and critically analyze how teachers perceive teaching of inquiry skills to secondary school students in UAE. The present study aimed to review teachers' perspectives about teaching inquiry skills to UAE secondary school students to identify common pedagogic practices and highlight challenges reported in included studies. Findings from this systematic review may potentially guide future studies to investigate further inquiry-based science teaching problems and challenges that have received little attention in the literature.

INQUIRY-BASED SKILLS & CRITICAL THINKING

Teaching Inquiry Skills

A form of active learning called inquiry-based learning starts when teachers pose questions, problems, or situations to the pupils (Enser, 2021; Jong et al., 2022). Inquiry-based learning engages learners in a variety of problem-solving abilities, in contrast to traditional

education, which often relies on the instructor to deliver information from their own subject-specific knowledge (Pedaste et al., 2015). In inquiry-based learning, instead of lecturing the knowledge, the instructor emphasizes the students' responsibility in the learning process and encourages their active participation. To acquire knowledge or find answers, inquirers identify problems, formulate questions and hypotheses, plan and carry out an experiment, collect and analyze data, and present findings and conclusions (Mäeots et al., 2011). Problem-based learning is a particular type of inquiry-based learning, where the context of learning is presented and experienced through authentic questions and problems within the learner's real world (Kokotsaki et al., 2016). Inquiry-based learning has been found to be tightly associated with the development of student competencies such as critical thinking and problem-solving (Lucietto et al., 2018; McNamara, 2022).

Inquiry Learning/Teaching in Science Education

Even though inquiry learning has been utilized as a teaching and learning strategy for decades, focusing on inquiry skills is a recently noted phenomenon in the public education sector (Borovay et al., 2019; Zadok-Gurman et al., 2021).

Dewey argued that scientific education should emphasize teaching science as a thought process instead of facts and figures to be memorized by heart (Del Fabbro, 2022; Thayer-Bacon, 2012). Joseph Schwab argued that science may be an adjustable and multifaceted inquiry-driven method of thinking and learning rather than a way to get to firm conclusions about the world in which we live. Schwab emphasized that scientific instruction should be more similar to what is done by scientists in the field. In line with the modern split of inquiry procedures, Schwab created three degrees of open inquiry (absorbing information without critically engaging with it, asking questions and seeking clarification and critical thinking and engagement) (Del Fabbro, 2022; Thayer-Bacon, 2012; Tomlinson, 1997). In an inquiry-based activity, students are challenged to find links between variables by being given questions, techniques, and resources. Students are presented with questions that promote their critical thinking to find their own methods for research using best learning strategies (e.g., critical thinking and planning). Throughout the process, phenomena are offered, but students must create their own questions and methods for investigation.

21st Century Skills

The talents deemed essential for employment and education in the modern economy have been referred to as 21st century skills (Aliu, 2021; Knotts, 2022; Rajandiran, 2021). Numerous initiatives have provided frameworks to describe and systematize these skills. Three areas of skills are identified by a joint government-corporate organization named the partnership for 21st century skills (P21, 2007):

1. Learning skills that involve innovation and creativity, planning, critical thinking and problem-solving, communication, and collaboration.
2. Literacy skills, which include but are not limited to media literacy, information literacy, and ICT literacy.
3. Life skills, which include adaptability and flexibility, initiative, social and cross-cultural skills, productivity and accountability, leadership, and responsibility (Aliu, 2021; Knotts, 2022; Kocak et al., 2021; Martnez-Bravo et al.,2022; Rajandiran, 2021).

Another similar attempt is the international research project assessment and teaching of 21st century skills (ATC21S). As part of the ATC21S project, 10 talents were identified and categorized into four groups:

1. Thinking styles (innovation and creativity; planning, critical thinking, problem-solving, and decision-making; learning to learn and metacognition).
2. Working styles (communication and collaboration).
3. Working tools (information literacy and ICT literacy).
4. Living styles (citizenship, life and career skills, and personal and social responsibility) (Martnez-Bravo et al., 2022; Rajandiran, 2021).

Along the same lines, the Organization for Economic Co-operation and Development (OECD) described 21st century abilities and categorized them under information, communication, ethics, and social effects (Ananiadou & Claro, 2009). 21st century skills include three main domains of skills:

(1) innovative thinking;

(2) information, media, and technology; and

(3) life and career skills (Trilling & Fadel, 2009).

Innovative thinking is achieved through an inquiry-based learning process, where problem-solving skills are optimized as a vehicle for knowledge discovery.

Critical Thinking

A major pillar of the 21st century skills, critical thinking is the process of examining the available data, facts, evidence, observations, and arguments in order to reach conclusions and generate sustainable knowledge. Defining critical thinking is complex, and there exist various explanations of what it means to analyze or assess factual material in a fair, skeptic, and objective manner (e.g., Alsaleh, 2020; Renatovna & Renatovna, 2021). Critical thinking is characterized by self-directed,

Table 1. Summary of population, subject, comparison, outcomes, & context (PSCOC) structure

Variable	Example
Population	Science teachers
Subject	Science teachers' perspectives on teaching inquiry skills
Comparison	Factors, challenges, difficulties, & issues
Context	Review of science teachers' perspectives about teaching inquiry skills to secondary students in UAE (factors & challenges)
Outcomes	Tends of science teachers' perspectives on teaching inquiry skills in UAE

self-disciplined, self-monitored, and self-corrective thinking (Yulduz, 2021). Critical thinking requires a commitment to overcoming established egocentrism and sociocentrism as well as excellent problem-solving and communication abilities (Zhou, 2022). Inquiry-based learning requires a certain level of critical thinking, through which the learner examines data in an objective fashion to reach conclusions.

STUDY AIMS & RESEARCH QUESTIONS

Through the present systematic literature review (SLR), we attempt to provide a thorough synthesis of science teachers' perspectives about teaching inquiry skills to students in UAE secondary schools. This SLR seeks to contribute to the literature by providing a comprehensive synthesis of science teachers' perspectives on teaching inquiry skills in UAE secondary schools. The study deliberately concentrated on UAE, which has multinational teachers from different countries, and recognizing its unique cultural and educational context within the broader Arab world that has great potential to be studied internationally (Government of the United Arab Emirates, n. d.). This SLR analyzed and reported on studies that explored

(1) the perspectives of teachers about teaching inquiry skills and

(2) the challenges and obstacles that may affect teaching inquiry skills to students in UAE secondary schools.

Even though the term "Arab world" has gained popularity as a general term, it is important to recognize that the various Arab nations exhibit significant differences in terms of their various cultural identities, customs and conventions, nationalities, religious beliefs, ethnicities, and political views (Khashman & Large, 2011). Accordingly, this study focused only on UAE context as the country has its own education system and population characteristics that may be different than other Arab countries. This study also evaluated other conceptual papers to support the conclusions. The purpose of this SLR was to explore science teachers' perspectives about teaching inquiry skills in secondary schools in UAE. The study's research questions were framed based on the PSCOC structure (population, subject, comparison, outcomes, and context), as shown in **Table 1**. The synthesis aimed to answer following primary and secondary research questions.

Primary Research Question

Based on findings from research conducted in UAE context, what evidence exists on science teachers' perspective regarding teaching inquiry skills?

Secondary Research Question

What are the most commonly reported factors that affect the relationship between teaching inquiry skills and students' critical thinking, one of the most required skills of 21st century in UAE?

METHOD

Search Process & Identification of Relevant Literature

Search process

A multi-step process was used to conduct a comprehensive search for relevant studies. First, electronic searches of EBSCOHost, Emerald, Google Scholar, JSTOR, ProQuest, SAGE Journals, Scopus, and Wiley Online Library databases were completed to locate studies in peer-reviewed journals. Scopus was chosen as the database because it is considered the largest and most comprehensive, containing information on more than 20,000 periodicals (Kolle et al., 2018). Every combination of the search terms (science, teaching, inquiry skills, 21st century skills, teacher perspectives) was used to systematically locate articles. To ensure that we did not miss any relevant studies, references from the initial set of identified studies were searched to locate additional articles. At the initial SLR stage, we adapted the framework utilized by Hamza et al. (2015) framework, which presents a systematic way of reviewing literature regarding a specific topic. More specifically, this framework allows researchers to follow precise steps, as follows:

(1) identifying the population and the subject to be investigated,

(2) comparing between articles studied to sort them in a way that achieves the research's main goal,

(3) identifying the context of articles presenting specific topics investigated that are associated with a specific issue (e.g., science teachers' perspectives and teaching inquiry skills),

(4) sorting articles based on the factors, challenges, difficulties, and issues highlighted, and

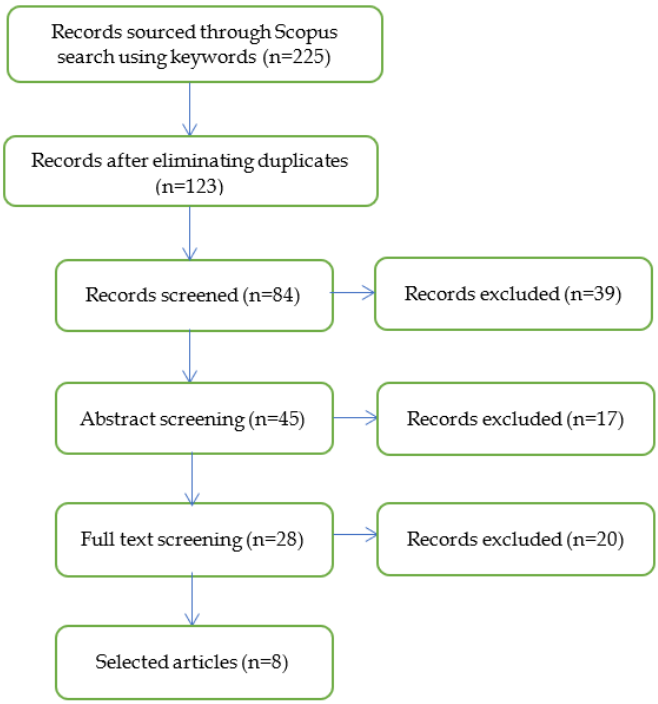

Figure 1. Process of identifying relevant literature through PRISMA (Fleming et al., 2014)

(5) presenting findings and drawing conclusions. For the purpose of the present SLR, science teachers in UAE secondary schools are the target population, and teaching inquiry skills is the topic of interest.

PRISMA methodology was adopted in this study to perform a systematic review of the previous literature. PRISMA enables the evaluation of studies and the ability to demonstrate their quality and outcomes (Klepinowski et al., 2020; Selcuk, 2019). Since PRISMA offers a step-by-step process for methodically reviewing qualitative, quantitative, and mixed method studies, it is considered appropriate for this SLR (**Figure 1**). The initial phase of the systematic search yielded 225 articles. After eliminating duplicate studies, 125 articles were eligible to undergo the selection criteria.

Study selection criteria

In this study selection, the researchers included both empirical and conceptual works linked with science teachers' perspectives research and teaching inquiry skills in UAE. The studies considered for the literature review were published between 2015 and 2023 in Scopus indexed Q1 and Q2 journals. Studies were selected for inclusion in the systematic review based on a pre-established set of criteria. For an article to be considered for potential inclusion, it had to be a study that

(1) explored science teachers' perspectives on teaching inquiry skills to students in UAE schools;

(2) addressed science teachers' perspectives regarding 21st century skills in UAE;

(3) explored science teachers' perspectives on promoting students' critical thinking in UAE; and

(4) investigated science teachers' perspectives in relation to factors associated with effective inquiry-based teaching practices.

After applying the predetermined set of study selection criteria, eight studies were included in the present SLR.

Coding & Evaluation of Study Quality

To summarize relevant information across studies, an extensive coding sheet was created to collect pertinent data related to the research themes. The first section of coding sheet was designed to extract data pertaining to:

(1) authors and year of publication,

(2) study context,

(3) sample,

(4) research goal,

(5) research design,

(6) data collection method, and

(7) major findings.

The second section of the coding sheet was designed to extract data pertaining to the factors associated with inquiry-based teaching practices that are associated with promoting students' critical thinking skills. Each study was reviewed thoroughly for the purpose of extracting reported factors found to be associated with inquiry-based teaching and associated with the development of students' critical thinking skills. Frequency count was conducted to report the number of studies that discussed similar factors, which was then converted to percentage of studies (e.g., number of studies reporting a specific factor, divided by total number of studies, multiplied by 100).

To evaluate the quality of reviewed studies, the quality criteria checklist was adapted from the systematic review conducted by Hamzah et al. (2022). The study quality checklist was adapted to include seven primary elements applicable to the different types of research methods: qualitative, quantitative and mixed (see **Table 2**). An overall ratio across questions was calculated to judge the quality of both quantitative and qualitative studies. The following scale was used to evaluate the quality of each reviewed study: yes=one point, no=zero point, and neutral=0.5 point, and the quality score ranged from zero (extremely low) to seven overall (very good).

Two independent coders (first and second authors) conducted the coding, and a point-by-point method was used to establish interrater reliability (El Zein et al., 2014). The percentage of agreement was calculated (e.g., agreements divided by the sum of agreements and disagreements, multiplied by 100) until the coders reached 100% agreement. When disagreements occurred, meetings were held to discuss the discrepancies until consensus was reached.

Table 2. Study quality checklist

Items	Answers
Are the research questions stated clearly?	Yes/no/cannot tell
Can the collected data address the research questions?	Yes/no/cannot tell
Is the sampling method appropriate for the research questions?	Yes/no/cannot tell
Is the selected sample representative of the population of interest?	Yes/no/cannot tell
Is the data collection method used appropriately?	Yes/no/cannot tell
Is the risk of nonresponse bias low?	Yes/no/cannot tell
Is the data analysis used appropriate to answer the research question?	Yes/no/cannot tell

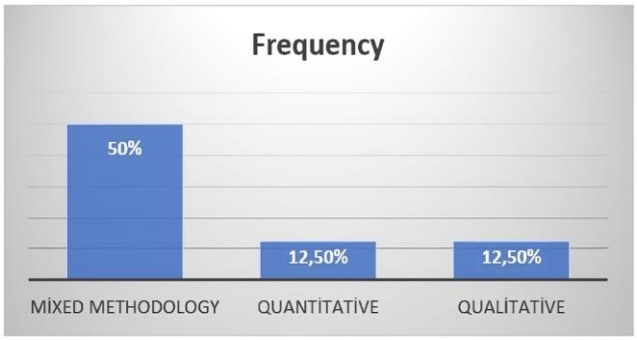

Figure 2. Studies by research method approach (Source: Authors' own elaboration)

RESULTS

The following section presents results addressing the current study's main research question.

The database search and study selection process yielded 28 empirical and conceptual studies. Duplicate studies, irrelevant research topics, and insufficient abstracts were all excluded from the original pool of studies. After applying the inclusion and exclusion criteria detailed before, only eight studies were considered suitable for coding and evaluation (see **Figure 1**).

The present SLR was able to pinpoint the common research methodologies applied in the included studies. **Figure 2** illustrates that the most commonly used research design employed by the reviewed studies was mixed-method research approach (75.0%; six studies); followed by qualitative approach (12.5%; one study) and quantitative approach (12.5%; one study). Four studies that employed mixed-method approach explored teachers' perspectives through conducting interviews and surveys (Amaireh, 2016; Eltanahy & Forawi, 2019; Mahdawi, 2019; Tairab & Al-Naqbi, 2017).

Table 3. Quality scores

QS	Very poor	Poor	Fair	Good	Very good	Total
	$a \leq 1$	$a \leq 2$	$a \leq 3$	$a \leq 4$	$a \leq 5$	
n			4	1	1	8
%	0.0	0.0	50.0	12.5	12.5	100%

Note. QS: Quality score & n: Number of studies

The remaining two studies that followed mixed methods approach employed survey design with quantitative and qualitative items (Dickson et al., 2015; Kadbey et al., 2015). The study employed qualitative approach gathered and analyzed data using interview design (Baroudi & Rodjan Helder, 2021). As for the study that collected and analyzed quantitative data, the authors utilized survey design (Arbid et al., 2020). The high percentages of mixed-methods studies could be attributed to the strong claim that combining both data collection tools commonly yield more in-depth insights into respondents' perspectives about a given topic.

Study quality evaluation revealed that the majority of reviewed studies were found to be of fair quality (see **Table 3**). More specifically, four studies (50.0%) were classified as fair, one study (12.5%) as good, and one study (12.5%) as very good. None of the reviewed studies were judged of poor or very poor quality (see **Table 3**).

The reviewed studies explored science teachers' perspectives about inquiry-based learning in UAE schools through surveys, interviews, and secondary data analysis. **Table 4** represents a summary of each reviewed study in terms of context, study aim, research design, sample (when applicable), data collection tools, and main findings. The sample size of participating teachers in the reviewed studies that employed surveys and/or interviews ranged from two teachers to 248 teachers.

Table 4. Summary of reviewed studies

No	Author/year	Research goals	RD	Sample	DC	Major findings
S1	Kadbey et al. (2015)	To research potential obstacles preventing English medium teachers (EMTs) from efficiently teaching science in accordance with new school model in Abu Dhabi & to provide helpful recommendations	Mixed method	248 teachers in Abu Dhabi	Survey (qualitative & quantitative questions)	It was discovered that EMTs believed there were a lot of obstacles standing in way of them efficiently teaching science. These barriers included language barriers (since students were not proficient in English), lack of professional development of teachers, & lack of appropriate barriers. Study made various recommendations to remove these barriers.

Note. RD: Research design & DC: data collection

Table 4 (continued). Summary of reviewed studies

No	Author/year	Research goals	RD	Sample	DC	Major findings
S2	Tairab and Al-Naqbi (2017)	To examine science students' & teachers' views of provision & implementation of inquiry-based instruction in UAE secondary school science classes	Mixed method	100 science teachers	Survey (100 teachers) & interviews (45 teachers)	Science teachers believed that curriculum materials lend themselves to supporting inquiry instruction, providing opportunities to plan investigations, ask questions during instruction, & use of science process skills. They also reported a few challenges such as their limited knowledge & skills related to inquiry instruction & time limitation.
S3	Dickson et al. (2015)	To investigate how well stated practices of private & public elementary school teachers in Abu Dhabi adhered to "best practice" in scientific education	Mixed method	248 teachers from public schools & 66 teachers from private school	Survey (qualitative & quantitative questions)	Respondents were asked to rate statements about their science classroom practices, such as whether they supported student collaboration, used IBL techniques, used hands-on, student-centered learning methods, applied science to real-world situations, & made connections between science & other subjects. Results of the study revealed, in contrast to study's hypothesis, that there were incredibly substantial discrepancies between teachers of private & public schools.
S4	Amaireh (2016)	To assess how 5 days of professional development for science teachers who use an inquiry-based learning method while teaching science (IBL)	Mixed method	39 science teachers (survey); four science teachers (interview)	Survey & interview	Main findings of study show that participating in IBL professional development program has enhanced teachers' attitudes toward, knowledge about, & practices of IBL.
S5	Mahdawi (2019)	To investigate effects of formative assessments (FA) on enhancing IBL of middle and high school students in Al-Ain City, UAE due to dearth of Arabic research on subject & significance of inquiry-based learning in science classes	Mixed method	20 science teachers & 24 students	Survey & interviews	Findings of this study indicate a beneficial relationship between FA & IBL. To assess IBL, increase learners' achievement in science, & incorporate FA more in educational process, some recommendations are provided by this investigation's findings.
S6	Eltanahy and Forawi (2019)	To investigate how IBL is perceived by science teachers & students in a private school in Dubai	Mixed method	2 science teachers & 50 students	Survey & interview	To obtain best outcomes for learning objectives, this private school under inquiry in study created its system in light of reform of science education. Regarding applying inquiry practice, teachers have favorable opinions. To be able to manage cooperative groups in their classrooms, they are more at ease using structured inquiry than other more sophisticated methods of inquiry.
S7	Arbid et al. (2020)	To investigate opinions of science instructors in secondary schools regarding integration of socio-scientific problems (SSI) into curriculum & elements that may help or hinder this integration	Quantitative	130 science teachers	Survey	Results showed that science teachers had favorable opinions of SSI's inclusion in curriculum. Participants mentioned knowledge, teaching methods, & resources as characteristics that made it easier to include SSI in curriculum.

Note. RD: Research design & DC: data collection

Table 4 (Continued). Summary of reviewed studies

No	Author/year	Research goals	RD	Sample	DC	Major findings
S8	Baroudi and Rodjan Helder (2021)	To investigate teachers' opinions & perceptions of inquiry-based instruction (IBI) & two nations were studied divergent viewpoints of impeding elements (UAE & Lebanon)	Comparative qualitative	15 teachers from Lebanon & 18 from UAE	Interview	Insufficient ICT & lab resources, poor professional development, a lack of time for lesson planning, & issues with classroom management are among challenges this study highlighted as making adoption of IBI in classrooms challenging. Viewpoints of Lebanese & UAE teachers differ from one another.

Note. RD: Research design & DC: data collection

Another key aim of the present SLR was to understand how the factors identified above affect teaching inquiry skills based on the perspectives of science teachers in UAE. The following sub-question also highlights the most frequent factors identified in the articles retrieved in SLR.

Based on main findings from the reviewed studies, science teachers' perspectives revealed that the following factors affected the relationship between teaching inquiry skills and students' critical thinking: knowledge, attitudes, resources, quality of professional development, time management, classroom management, teaching strategies, student readiness, cultural influence, curriculum, planning, questioning, demographic variables, problem-solving, group dynamics, feedback, language, and socio-specific factors. The factor with the strongest evidence to support students' critical thinking skills was *other teaching and learning practices* applied in the classrooms (Arbid et al., 2020; Baroudi & Rodjan Helder, 2021; Dickson et al., 2015).

Table 5 presents the factors linked to students' critical thinking skills based on evidence from the reviewed studies. The factor with the second strongest evidence was *quality of teachers' professional development* (Baroudi & Rodjan Helder, 2021; Kadbey et al., 2015; Tairab & Al-Naqbi, 2017). Teachers' knowledge and skills in inquiry-based teaching (Arbid et al., 2020; Baroudi & Rodjan Helder, 2021), attitudes (Amaireh 2016; Baroudi & Rodjan Helder, 2021), ICT and lab resources (Baroudi & Rodjan Helder, 2021; Kadbey et al., 2015), time management skills (Eltanahy & Forawi, 2019; Kadbey et al., 2015), and lesson planning (Eltanahy & Forawi, 2019; Baroudi & Rodjan Helder, 2021) were found by a few studies to be associated with students' critical thinking skills in science. The following factors were each discussed by one of the reviewed studies as a contributor to students' level of critical thinking:

(1) classroom management and

(2) student characteristics, cultural factors, curriculum materials, demographic variables, group dynamics, constructive feedback, language, and inclusion issues.

Table 5. List of factors linked to students' critical thinking skills

Factors	Studies	P (%)	SE
Other teaching practices (e.g., student-centered, project-based, problem-solving, & questioning)	Arbid et al. (2020), Baroudi and Rodjan Helder (2021), Dickson et al. (2015), & Eltanahy and Forawi (2019)	50.0	Yes
Quality of professional development	Baroudi and Rodjan Helder (2021), Kadbey et al. (2015), & Tairab and Al-Naqbi (2017)	37.5	Yes
Teachers' knowledge & skills	Arbid et al. (2020) & Baroudi and Rodjan Helder (2021)	25.0	Yes
Students' attitudes	Amaireh (2016) & Baroudi and Rodjan Helder (2021)	25.0	Yes
ICT, lab, & resources	Baroudi and Rodjan Helder (2021) & Kadbey et al. (2015)	25.0	Yes
Time management	Eltanahy and Forawi (2019) & Kadbey et al. (2015)	25.0	Yes
Lesson planning	Baroudi and Rodjan Helder (2021) & Eltanahy and Forawi (2019)	25.0	Yes
Classroom management	Baroudi and Rodjan Helder (2021)	12.5	Yes
Student characteristics	Arbid et al. (2020)	12.5	Yes
Cultural influences	Arbid et al. (2020)	12.5	Yes
Curriculum materials	Kadbey et al. (2015)	12.5	Yes
Demographic variables, e.g., gender, teaching experience, & subject taught	Mahdawi (2019)	12.5	Yes
Student behaviors	Kadbey et al. (2015)	12.5	Yes
Group dynamics	Eltanahy and Forawi (2019)	12.5	Yes
Constructive feedback	Mahdawi (2019)	12.5	Yes
Language	Kadbey et al. (2015)	12.5	Yes
Inclusion of socio-scientific issues	Arbid et al. (2020)	12.5	Yes

Note. P: Percentage & SE: Significant effect

DISCUSSION

SLR selected eight studies in UAE contexts addressing inquiry skills' teaching by exploring teachers' perspectives regarding the effective factors. These studies examined the following issues:

(1) science teachers' perspective on teaching inquiry skills in UAE;

(2) science teachers' perspective on teaching 21st century skills in UAE;

(3) science teachers' perspective on teaching critical thinking in UAE; and

(4) science teachers' perspective on teaching science inquiry skills in UAE.

Such findings are true as it agrees with Jarrah and Almarashdi (2019) who recommended further studies in this regard, in addition, Jamil et al. (2022) stated critical thinking as main factor to enhance teaching inquiry skills is important to be further highlighted and investigated. Accordingly, future studies in UAE context that can enhance teaching inquiry skills are recommended.

We have provided some data in this SLR about the perspectives of the teachers and how they instruct inquiry skills in UAE. By doing this, we were able to pinpoint certain opportunities for improvement as well as some difficulties in implementing the teaching of inquiry skills in science topics. As this study demonstrated, there are opportunities for UAE educational system to use pronunciation pedagogy. An examination of the difficulties, inconveniences, and problems that could be experienced while using critical thinking to the development of inquiry skills.

Socio-Psycho Factors

This study pointed out that socio-psycho factors can play an important role in enhancing teachers' teaching of inquiry skills e.g., attitude and motivation.

Classroom Management

Some teachers pointed that time managements, practices, curriculum, ICT, Lab, resources, quality of professional development can also affect the process of teaching inquiry skills.

Teachers' Competence

It is also indicated by articles that teachers' competence is an important factor to enhance teaching practices. The selected papers, more specifically, pointed out some important factors including teachers' knowledge, competence, and support.

Student Characteristics

Some factors including students' autonomy, majority, centralizations of learning process can enhance teaching of critical thinking when focusing on inquiry skills.

Teaching Practices

Undoubtedly, teaching methods can be a main factor to improve the process of inquiry skill teaching.

More specifically, this study pinpointed factors that were discussed in previous studies. **Table 5** presents the most investigated factors affecting teaching inquiry skills based on science teachers' perspectives in UAE.

Due to the fundamental problems with how science is typically taught that have been demonstrated through studies on science instruction and science learning, the scope and structure of science education should be altered (e.g., Cooper et al., 2019; Olson, 2018). This modernized viewpoint on science education and learning is reflected in new science standards like the Next Generation Science Standards (NGSS). In place of simply reading about science in books or memorizing the steps of the scientific method, students are today expected to learn science by really "doing science" (Akerson & Buck, 2023). Even while the advantages of teaching science process skills are becoming more and more clear, the biggest challenge is the amount of time required for instruction. Every teacher is conscious of the limited amount of time they have with their students; therefore, they must carefully plan how to spend that time to achieve the course objectives. This brings up the age-old debate between emphasizing skill development and inquiry while concentrating on a smaller number of topics and covering as much content as feasible. Long-term education and course-wide redesigns have received the majority of the attention when it comes to incorporating science process skills. These major alterations need the instructor to dedicate a large amount of time, and class time needs to be rescheduled (e.g., Al-qadi & Naser, 2022; Alzobidy & Naser, 2022; Crogman et al., 2015; Naser & Hamzah, 2018). Other initiatives to highlight science process skills focused on integrating them into lab and research settings, although not all curricula and instructors have access to this option (e.g., DebBurman, 2002; Kramer, 2018; Voorhees et al., 2022).

This section discusses potential recommendations that might be put into practice in the future to support the teaching and learning of critical thinking among science students in UAE. First, attitudes and levels of motivation might be crucial for teachers as well as pupils when it comes to the adoption of socio-psycho aspects (Gonzalez-Gomez et al., 2022; Poultsakis et al., 2021). Students also need to have sufficient support such as ample practice opportunities during classes (Dickson et al., 2016; Tairab & Al-Naqbi, 2017). Besides, the use of resources and labs can also create positive attitudes and high levels of motivation among students as well as teachers (Baroudi et al., 2021; Ray, 2017). Engaging

learners in learning critical thinking can be an essential target of teachers as well as schools. Hence, there should be a focus on teachers' roles and students' roles in creating such engagement (Ayouby & Mahmoud, 2016; Jarrah & Almarashdi, 2019; Shaito, 2019). Additionally, teaching styles, methods, and equipment including curriculum materials, inquiry instruction, opportunities to plan investigations, asking questions during instruction and use of science process skills are necessary tools when teaching inquiry skills (Jamil et al., 2021; Shakera & Salehb, 2021; Tairab & Al-Naqbi, 2017). Accordingly, Teachers can also use effective teaching methods and/or styles when teaching critical thinking.

Demographic variables including gender, teaching experience and subject taught can also enhance the effectiveness of teaching inquiry skills (Rashid, 2021; Tairab & Al-Naqbi, 2017; Wakui et al., 2021). For example, Tairab and Al-Naqbi (2017) conducted a study in order to assess the demographic variables' impact containing teaching experience, gender, and subject taught, specifically, the demographic variables' impact covering all provision levels in the curriculum materials and the effective classrooms' actual implementations to provide comprehensive views about demographic variables.

CONCLUSIONS

The study confirmed that internal factors such as beliefs and perception have a specific degree of influence on the studied factors and teaching inquiry skills by looking at critical thinking based on the science teachers' perspectives. Apart from that, according to secondary science teachers in UAE, the factors that contribute most to teaching inquiry skills are related to specific teaching practices such as student-centered learning, project-based learning, problem solving, questioning, constructive feedback and more. The problem is often tied to information that has been or will be researched. Incorporating artistic, technical, and creative elements into science learning and teaching methodologies has been one of the important approaches, especially when tying them to other academic disciplines and cultural contexts. Based on SLR, this study recommends further investigations to address the enhancement of critical thinking teaching among UAE school students of science. More precisely, this study recommends conducting studies using experimental and quasi-experimental research designs in order to implement effective teaching methods including socio-cultural aspects, and to be further effective e.g., active learning strategy, socio-cultural theory, constructivism theory, and any effective theory in this regard.

In addition, this study recommends further research work that can enhance socio-psycho factors e.g., motivation, attitudes, self-efficacy, and affective filter hypothesis. Furthermore, there should be a great focus on 21st century skills including critical thinking, teamwork, problem-solving, research skills, presentation skills, interpersonal communication skills, negotiation skills, creativity, and innovation. This SLR significantly presents useful variables and teaching theories after reviewing related studies in UAE context looking at teaching inquiry skills based on the perspectives of science teachers. Accordingly, such contribution of this SLR study can have value in the field of UAE's science education research.

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