

Mapping Measurement Scales for the Assessment of Learning Environments

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Abstract

This article aims to map the scales validated in the international literature for the assessment of learning environments. A systematic literature review was carried out in articles from the web of Science database in the period from 1970 to 2020. After completing the three stages proposed by Tranfield, Denyer, and Smart (2003), 94 articles were selected to compose the final sample. Most of the articles analyzed were published from 2011 to 2020 (54.2%). Barry J. Fraser is the author who published most of the articles from the analyzed sample (10), which confirms his representativeness in studies involving the subject. Most articles involve the area of Education and Educational Research (78.7%). Twenty scales used to assess the learning environment were identified. The What Is Happening In This Class? Instrument is the most cited and most used in the articles analyzed. We also identified that the six dimensions of this instrument appear in four or five different scales, which reveals its contribution to the construction of assessment scales. The study results can assist in the development of a multidimensional scale of learning environments.

Keywords: assessment, education; educational research, learning environment, measurement scale, systematic review

1. Introduction

The term Learning Environment (LE) does not relate to a new concept, it is considered a field of study that has shown remarkable growth, diversification and internationalization, and that has been refined by several influential researchers over the past 60 years when developing studies that helped to understand and analyze the phenomenon (Fraser, 1998; Wolf & Fraser, 2008; Mutlu & Yildirim, 2019).

LE can still be considered an emerging concept in Adult Education (Merriam & Brockett, 2007) and the consensus about its significance is still restricted, as well as its characterization, its main elements and how its interaction occurs (Day, 2009). LE can be broadly characterized in different situations and contexts and with several components (Abualrub & Stensaker, 2018), which demands a greater understanding of its configuration and its implications for teaching and learning.

For Hiemstra (1991), the LE is multidimensional, complex and involves physical, social, behavioral and pedagogical elements that interrelate and impact students' learning process.

Frenzel, Pekrun, and Goetz (2007) emphasize that LE can be conceptualized as the students or teachers' subjective perceptions about the space in which learning takes place. Students' perception of the classroom environment is related to the learning outcome (Wolf & Fraser, 2007). Such aspect is also supported by Asiyai (2014), when he highlights that the students' impression of the classroom can have a positive or negative impact on learning, as they are able to perceive the nature of the classroom LE. Therefore, their perception can affect their attitude towards learning.

Fraser (2001) highlights the role of the teacher in the LE, and emphasizes the need to obtain information from this space so that it can be useful in providing feedback and to guide attempts to improve teaching and learning.

The term LE encompasses learning resources and technologies, teaching facilities, modes of learning and connections with social and global contexts, in addition to including cultural and behavioral dimensions, such as the role of emotions in learning (Warger, Serve, & Dobbin, 2009).

One of the relevant aspects in studies on LE involves their assessment, based on aspects related to engagement (Sökmen, 2019), motivation (Radovan & Makovec, 2015; Kember, Ho, & Hong, 2010), relationship between teacher-student or among students (Cureton & Gravestock, 2018; Bonem, Fedesco, & Zissimopoulos, 2020), virtual or remote environments (Merriam, Caffarella, & Baumgartner, 2007; Kocdar, Karadeniz, Bozkurt, & Buyuk, 2018), hybrid-learning environment (Geng, Law, & Niu, 2019; Tang & Shaw, 2016), emotion (Pekrun, 2019), among others. Many studies adopt quantitative approaches and seek to measure dimensions that involve the LE, such as physical, psychological, social, technological, and pedagogical dimensions (Soneral & Wyse, 2017). Thus, the need to consider and discuss the assessment of the effectiveness of these environments is evident (Warger, Serve, & Dobbin, 2009).

This article aims to map the scales validated in the international literature for the assessment of LE. The main contributions of this study are: a) the evaluation of scientific production on the subject of LE linked to the assessment scales of individuals' perceptions of the environment in different learning contexts can help researchers and practitioners in choosing the most appropriate instruments for their research interests; b) identification of the main variables for the analysis of LE that are common in most instruments used in the literature can help to delimit topics of interest for future studies; and c) to raise reflections on the multidimensionality of the assessment of LE.

2. Assessment of Learning Environments

The development of instruments to assess individuals' perceptions of the classroom environment started in the late 1960s (Mcminn & Aldridge, 2020). Thus, works of Walberg (1968) and Moos (1974) stand out as pioneers in studies on perceptions of the classroom environment, being considered a milestone in the historical development of the field of LE.

The field of LE studies presents, in the course of its historical perspective, the availability of a variety of validated and reliable instruments used in research applications. The diversity of questionnaires developed is a striking feature of the field, used to assess students' perceptions related to the classroom environment (Zandvliet & Fraser, 2019; Fraser, 1998).

It is considered that assessing the classroom environment is, then, essential for a common good, considering its influence on the academic performance of students and on the learning process, as well as allowing to broaden the vision of what teaching is, regarding how teachers can contribute to the promotion of an enabling environment for learning.

According to Fraser (2012), after pioneering research by Herbert Walberg and Rudolf Moos in the United States on LE and pioneering programs launched in the Netherlands and Australia, this line of research began to spread around the world.

Herbert Walberg and Rudolf Moos introduced seminal independent research programs that were starting points for contributing to research on the subject. Herbert Walberg contributed to the development of the Learning Environment Inventory (LEI) instrument, as part of the research and assessment activities related to the Harvard Project Physics (Walberg & Anderson, 1968). Rudolf Moos, in collaboration with Edison Trickett (Trickett & Moos, 1973; Moos & Trickett, 1974), developed social climate scales for various human environments, resulting in the development of the Classroom Environment Scale-CES instrument (Fraser, 2012).

Moos (1979) developed a conceptual framework composed of three dimensions to characterize the human environment: a) relationship (refers to relationships among individuals in a specific environment); b) personal development (refers to the opportunities that individuals must develop in the environment); and c) maintenance and alteration of the system (related to the degree to which the environment is pleasant, organized and open to change). Based on the contribution of Moos (1979), different teacher behaviors, interactions in the classroom, classroom assessment practices, materials, and physical conditions of the classroom, as well as all atmospheric characteristics available in the educational institution or classroom were conceptually included in the term LE (Mutlu & Yildirim, 2019). Thus, a practical application of LE questionnaires involves providing teachers feedback aiming at improving the classroom environment (Deieso & Fraser, 2019; Lim & Fraser, 2018). In this regard, Dorman (2002) also corroborates by emphasizing that the application of instruments allows students to make valid judgments about their LE, and that these assessments can be considered to improve it.

When considering the importance of the LE to the personal development, Merriam, Caffarella, and Baumgartner (2007) highlight that people in adult life can have learning experiences in different contexts, places, ways and through different modalities of education. In this sense, three types of contexts are highlighted in which learning takes place: formal institutions, non-formal learning activities and informal or self-directed contexts.

The field of research on LE has rapidly developed, considering the various applications of instruments to assess the

classroom environment, which cover different lines of research and perspectives, as follows: a) studies on the relationship between the classroom environment and student outcomes; b) evaluation of educational innovations; c) practical attempts by teachers to improve classroom climate; d) differences between students and teachers' perceptions in relation to the same classrooms; e) combination of qualitative and quantitative methods; f) school psychology; g) transnational studies; h) assessment between the current environment and the students' preferred environment; i) teacher education; and j) teacher assessment (Dorman, 2002; Fraser, 2012; Lim & Fraser, 2018; Deieso & Fraser, 2019).

3. Method

This research uses a Systematic Literature Review (SLR) method and aims to map the instruments used to measure the LE. Thus, we sought to contribute to knowledge on LE from the mapping of published articles on the subject, but not in a broad perspective, rather focusing on the identification of scales that are used in studies on the field of research in the educational context over the years.

The database used to locate the SLR articles was the Web of Science, and it covered a period of 50 years (1970 to 2020). The choice of this electronic database is justified since this is one of the largest databases of literature available on quality websites and that has also dominated the field of academic reference, covering the oldest publications and most scientific fields (Falagas, Pitsouni, Malietzis, & Pappas, 2008). The applied time frame aimed to identify the LE assessment instruments used throughout the historical development of the field of studies, to the most recent context on the subjective students and teachers' perceptions about the place where learning takes place through instruments developed and applied in research.

The model proposed by Tranfield, Denyer, and Smart (2003) was adopted to operationalize this review. For the authors, SLRs should be developed in three stages:

- Stage I: Review Planning: Phase 0: Identifying the need for a review; Phase 1: preparation of the revision proposal; and Phase 2: development of the review protocol.
- Stage II: Conducting the systematic review: Phase 3: research identification; Phase 4: selection of studies; Phase 5: quality assessment of studies; Phase 6: data extraction and process monitoring; and Phase 7: data synthesis.
- Stage III: Final report and knowledge dissemination: Phase 8: report writing, and Phase 9: search for evidence in practice.

For the development of the review protocol, we defined search strings with keywords that would favor the identification of articles corresponding to the main LE assessment instruments. The strings were applied to the title and abstract of the works available in the Web of Science database and, during the search procedure, the filter was applied so that only records entered in the form of scientific articles were selected.

A test was carried out to verify the amount of return for the developed keywords and whether they would be effective in identifying these studies. Table 1 shows the results obtained with the search strings and the tests performed.

Table 1. Search string information and quantity obtained

Category	Test	Search Strings	Web of Science
Learning Environment Assessment Instruments	1	"Classroom learning environment" or "Learning environment survey" or "Learning environment instrument" or "learning environment scale" or "evaluating (assessing?) classroom learning environment" or "class* inventory" or "learning environment inventory" or "classroom environment questionnaire" or "classroom environment inventory" or classroom environment scale" or "learning environment questionnaire"	423
	2	"What Is Happening In this Class?"	17
Total			440

The search strings prepared were based on the literature related to the LE theme, as well as by observing the nomenclature of the main historically important assessment instruments in the field of study, namely: Learning Environment Inventory (LEI); Classroom Environment Scale (CES); Individualized Classroom Environment Questionnaire (ICEQ); College and University Classroom Environment Inventory (CUCEI); My Class Inventory (MCI); Questionnaire on Teacher Interaction (QTI); Science Laboratory Environment Inventory (SLEI);

Constructivist Learning Environment Survey (CLES); and What Is Happening In this Class? (WIHIC) (Fraser, 1998; Fraser, 2012; Zandvliet & Fraser, 2019).

The first test performed generated 423 occurrences from the keywords highlighted in Figure 1. Subsequently, the titles and abstracts of the articles were read to identify the works that would be included in the SLR, that is, the articles that were related to the LE research field, and that presented the use of instruments in the studies validated on the proposed theme.

Given the initial analysis of these articles, considering the reading of the abstracts, it was noticed that few studies were related to the What Is Happening In this Class? (WIHIC) questionnaire, since it is considered one of the most used instruments for assessing classroom LE in many countries (Fraser, 2012). Thus, in a second moment of testing, it was decided to perform a search using the term “What Is Happening In this Class” to reach this instrument, given that the previous terms did not serve effectively in the search for the studies that used this scale. A total of 17 occurrences were obtained at this stage.

From the search performed in the two tests, a quantity of 440 articles was obtained, according to the procedure adopted with the keywords indicated in Table 1, and filters were created to select the most relevant articles to integrate the sample of the SLR, which are indicated in Table 2.

Table 2. Criteria used to exclude articles from the SLR

Order	Exclusion Criteria	N° of excluded articles
1°	Articles that were not related to the Learning Environment theme	189
2°	Articles and instruments directed towards the health area	75
3°	Articles that used the Qualitative approach	5
4°	Articles in Languages other than English (e.g.: Japanese)	2
5°	Non-Open Access Articles	10
6°	Duplicate articles	5
Total number of excluded articles		286

After applying the exclusion criteria, a total of 154 occurrences were obtained. Then, the selection of articles that would compose the final sample of the SLR was carried out and, for this, a single eligibility criterion was used: articles that used validated instruments to assess the LE. Thus, the 154 articles were read, with an emphasis on the analysis of the methodology in order to know the characteristics and specificities of the instruments used in the studies, and to identify and analyze the scales used to, subsequently, make the decision on inclusion and selection. The analysis provided the opportunity to identify a total of 94 records that were selected for the final SLR sample. Figure 1 summarizes the operational process in the selection of articles.

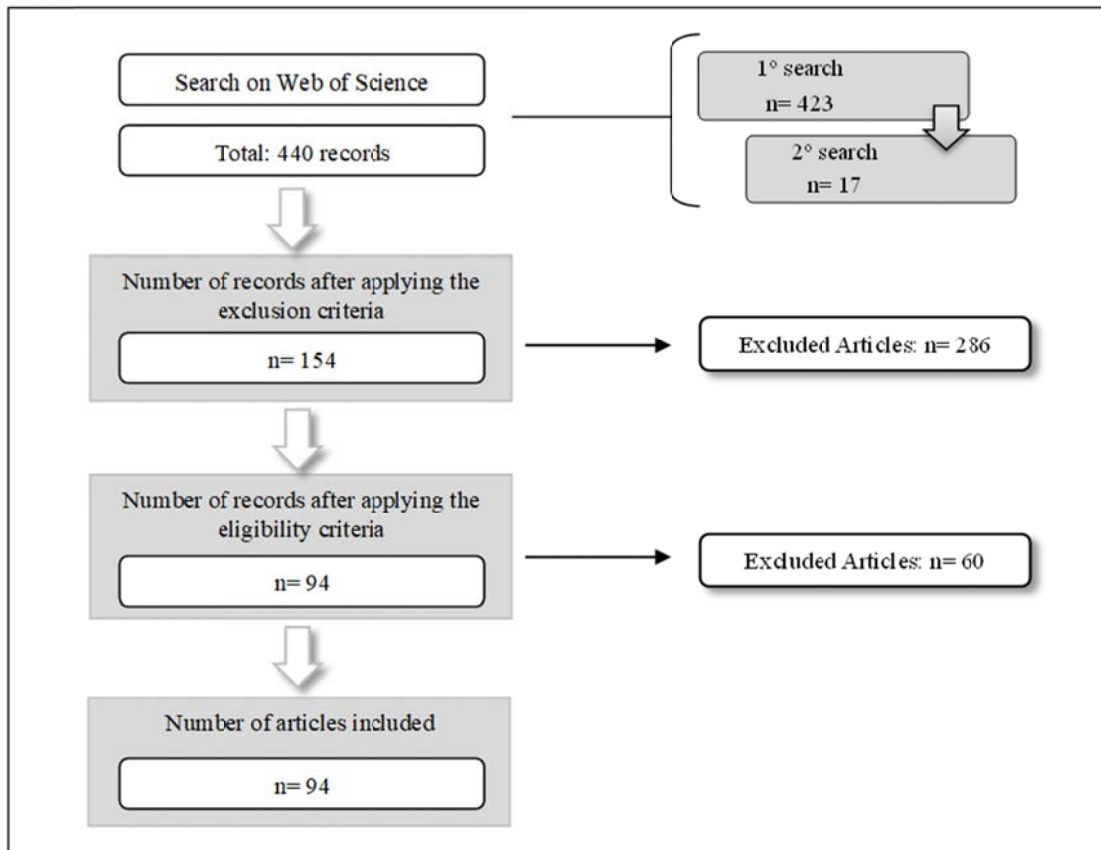


Figure 1. SLR article selection process

4. Results

The articles that comprise the sample involve studies carried out in the educational context, so that the studies could assess the perception of individuals about their LE, specifically the classroom, where the formal learning process takes place. Furthermore, it was identified that the studies involved three teaching categories: Elementary School; Middle and High School; and Higher Education, as well as involving the assessment of teachers' perception about the LE.

Most of the LE assessment scales identified as a result of this SLR were developed based on the conceptual framework proposed by Moos (1979) consisting of three dimensions to characterize the human environment: relationship, personal development and system maintenance and change.

The number of publications of the articles selected in the SLR increased over the years. 54.2% of the analyzed scientific production was published over the past 10 years, showing an increase in research using scales in the assessment of LE in recent years, which signals the potential of this field of study and the approach to investigate the perceptions of individuals about the space in which they have experiences in the teaching and learning process, in addition to revealing their interest in the subject.

Table 3 presents the ranking with the 5 main journals that published articles of a quantitative nature, in the Web of Science database, on the field of study, and that used instruments to assess LE.

Table 3. Ranking of the most published journals

Ranking	Journals	Frequency
1	International Journal of Science and Mathematics Education	6
2	International Journal of Science Education	5
2	Journal of Educational Research	5
2	Research in Science Education	5
2	Research in Science Technological Education	5
Total		26

The International Journal of Science and Mathematics Education occupied the first place in the ranking with the largest number of articles published on LE scales. When considering the quantitative number of publications in the five main journals (26), we found that these journals represent 28% of occurrences involving the theme of LE of the selected articles. Next, Table 4 shows the six main authors who most published articles related to the subject.

Table 4. Ranking of authors who most published articles

Ranking	Authors	Frequency
1	Barry J. Fraser	10
2	Jill M. Aldridge	5
3	Chin-Chung Tsai	4
4	Edison J. Trickett	3
4	Semra Sungur	3
4	Yezdan Boz	3
4	Yasemin Tas	3
4	Shih-Chyueh Chuang	3

Table 4 reveals the significant contribution of Barry J. Fraser as the author who most contributed to the dissemination of knowledge about LE in the articles analyzed. Two instruments developed and validated with the participation of the researcher (Fraser, Fisher, & McRobbie; 1996; Taylor, Fraser, & Fisher; 1997) are the most used by the articles that comprise the sample of this SLR (see Table 6). Table 5 reveals relevant information by indicating the main areas of research that carried out studies in the educational context, assessing teachers and students' perception about the environment in which they experience teaching and learning and their implications for the student's academic education.

Table 5. Research areas that most stood out in the articles

Research area	Frequency
Education and Educational Research	74
Psychology	20
Social Work	4
Social Sciences – Other topics	4

The most representative research area was Education and Educational Research, which reveals the interest of studies in the educational context with focus on understanding the importance of the LE in the education of individuals and in their teaching and learning process. The second that stood out was in the field of Psychology, which shows the need to reflect and study about the influences of the LE on the emotions, behaviors and attitudes of individuals, their motivation to learn and their well-being.

The analysis of the articles from the sample of this study allowed the identification of 20 instruments used to analyze the LE. Table 6 presents the summary of the analysis related to each of the LE assessment scales, highlighting the dimensions that comprise the scale, the total number of items, as well as its objective and specificities for use in educational contexts.

Table 6. Information on the main instruments for assessing the learning environment

Learning Environments Rating Scale and their respective authors	Scale dimension	Total scale items	Objective and assessment characteristics of the instrument
Constructivist Learning Environment Survey (CLES) (Taylor, Fraser, & Fisher, 1997)	Personal Relevance; Uncertainty of Science; Critical Voice; Shared Control; Student Negotiation	36	Assess the degree to which the classroom environment is consistent with a constructivist epistemology, and that can help teachers reflect on their epistemological assumptions and reshape their teaching practice. Furthermore, it presents a perspective focused on students as co-builders of their own knowledge. The scale has five response alternatives, as follows: 1- Almost always; 2- Often; 3- Sometimes; 4- Rarely; 5- Almost never.
Learning Environment Inventory (LEI) (Fraser, Anderson, & Walberg, 1982)	Cohesiveness; Friction; Favoritism; Cliquesness; Satisfaction; Apathy; Speed; Material Environment; Difficulty; Competitiveness; Diversity; Formality; Goal direction; Disorganization; Democracy	105	Assess students' perceptions about implications of the classroom's social climate on learning. The LEI instrument has two distinct objectives: (a) to assess students' individual perceptions of the classroom environment and (b) to assess the classroom learning environment as a group. On the scale, the individual expresses the degree of agreement with each statement using four response alternatives: strongly disagree, agree and strongly agree.
Classroom Environment Scale (CES) (Moos & Trickett, 1974)	Involvement; Affiliation; Teacher Support; Task Orientation; Competition; Order and Organization; Rule Clarity; Teacher Control; Innovation	90	Measure students and teachers' perceptions regarding the psychosocial aspects of the classroom environment. The CES instrument allows the assessment of students' perceptions about the actual environment and the preferred environment of the classroom, as well as teacher's perceptions about the actual environment.
Individualized Classroom Environment Questionnaire (ICEQ) (Rentoul & Fraser, 1979)	Personalization; Participation; Independence; Investigation; Differentiation	50	Measure perceptions of the classroom environment through dimensions that differentiate individualized classrooms from conventional ones. As the Classroom Environment Scale (CES) instrument, the ICEQ allows the assessment of students' perceptions about the actual classroom environment, students' perceptions about their preferred environment, and teachers' perceptions about the actual environment. Each item is scored on a five-point scale, as follows: 1- Almost Never, 2- Rarely, 3- Sometimes, 4- Often, and 5- Very Often.
My Class Inventory (MCI) (Fisher & Fraser, 1981)	Cohesiveness; Friction; Satisfaction; Difficulty; Competitiveness	38	The MCI instrument is a simplified version of the Learning Environment Inventory (LEI) instrument and measures five dimensions in relation to the social climate of the classroom. The use of these instruments (LEI and MCI) involves providing feedback to teachers about the classroom; assess new educational programs and investigate the effects of classroom climate on student learning. Item wording has been simplified to improve readability in relation to the LEI, and it has a two-point answer format: Yes-No.

Questionnaire on Teacher Interaction (QTI) (Wubbels, Créton, & Hooymayers, 1985)	Helpful/friendly; Understanding; Dissatisfied; Admonishing; Leadership; Student Responsibility/Freedom; Uncertain; Strict	48	<p>Measure behavior/interpersonal relationships between teachers and students in classrooms.</p> <p>It was developed based on a theoretical model proposed by Wubbels, Creton and Hooymayers (1985), and it is characterized by two dimensions: proximity (it can be indicated on a continuum that has cooperative behavior at one end and oppositional behavior at the other end) and influence (it may be indicated on a continuum that has dominant behavior at one end and submissive behavior at the other end).</p> <p>The QTI was developed to assess students' perceptions about eight behavioral aspects present in the model, whose items are allocated into eight dimensions. Each item has a five-point response scale ranging from Never to Always.</p>
College and University Classroom Environment Inventory (CUCEI) (Fraser & Treagust, 1986)	Personalization; Involvement; Student Cohesiveness; Satisfaction; Task Orientation; Innovation; Individualization	49	<p>Assess students and teachers' perception about the psychosocial environment of the classroom of Higher Education Institutions.</p> <p>Each item is answered on a four-point scale with the following alternatives: 1- Totally agree; 2- I agree; 3- I disagree; and 4- I totally disagree.</p>
Science Laboratory Environment Inventory (SLEI) (Fraser, Giddings, & McRobbie, 1995)	Student Cohesiveness; Open-Endedness; Integration; Rule Clarity; Material Environment	35	<p>Assess perceptions of psychosocial environment of classes in the science laboratory in high school or higher education, considering the importance given to laboratory environments in science education.</p> <p>Thus, it seeks to assess students' perceptions about the classroom as a whole and their perceptions about their own role in the class.</p> <p>The SLEI has five dimensions (each with seven items) and five response alternatives, as follows: 1- Almost Never; 2- Rarely; 3-Sometimes; 4- Often; and 5- Very often.</p>
What Is Happening In this Class? (WIHIC) (Fraser, Fisher, & McRobbie, 1996)	Student cohesiveness; Teacher support; Involvement; Investigation; Task orientation; Cooperation; Equity	56	<p>Assess students' perceptions of social and psychological relationships that occur in learning environments.</p> <p>The WIHIC instrument was developed from the combination of existing questionnaire scales with contemporary dimensions of relevance to bring parsimony to the field of study of learning environments.</p> <p>Each item applies a five-point Likert response format, as follows: 1- Almost never; 2- Rarely; 3- Sometimes; 4- Often; and 5- Almost always.</p>
Constructivist Multimedia Learning Environment Survey (CMLES) (Maor & Fraser, 2005)	Learning to Communicate; Learning to Investigate; Learning to Think; Relevance; Ease of use; Challenge	30	<p>Assess the degree to which students and teachers perceive that the classroom environment engages students as for the perspectives of negotiation, investigative learning, and reflective thinking.</p> <p>The questionnaire also assesses teachers' and students' perceptions about the learning environment when using online multimedia programs, students' reactions to the interactive multimedia program, and whose teachers use a constructivist-oriented approach as a reference for the teaching and learning process.</p> <p>The CMLES consists of six dimensions with five items each, with frequency response alternatives ranging from Almost Never to Always.</p> <p>In addition, it consists of two versions: actual (assess perceptions about the current classroom environment) and preferred (attributing opinions about the ideal classroom environment).</p>

Constructivist On-Line Learning Environment Survey (COLLES) (Taylor & Maor, 2000)	Professional Relevance; Reflective Thinking; Interactivity; Cognitive Demand; Affective Support; Interpretation of Meaning	24	<p>Assess student-teachers' perceptions about the online learning environment as a space that enables the construction of reflective and collaborative learning, as well as assessing the student's involvement in learning situations and interaction.</p> <p>The COLLES instrument is used to assess higher education courses in the online modality, especially graduate programs that consider social constructivism as a pedagogical reference.</p> <p>Its structure features a five-point frequency rating scale with the following options: Almost Never, Rarely, Sometimes, Often, and Almost always.</p>
Technology Rich Outcome Focused Learning Environment Inventory (TROFLEI) (Aldridge & Fraser, 2003)	Student Cohesiveness; Teacher Support; Involvement; Task Orientation; Investigation; Cooperation; Equity; Differentiation; Computer Usage; Young Adult Ethos	80	<p>Assess results in two ways: actual form assesses students' perceptions of their actual classroom environments; and the preferred form assesses students' perceptions of the classroom environment considering how they prefer or perceive it as ideal.</p> <p>These two ways enable a comparison between students' perceptions about their preferred classroom environment and what it really is like.</p> <p>The instrument has 10 dimensions, seven of which are linked to the What Is Happening In this Class? (WIHIC) instrument, which was used as the basis for its development. Instrument items are rated on a five-point scale ranging from Almost Never to Almost Always.</p>
Web-Based Learning Environment Instrument (WEBLEI) (Chang & Fisher, 2003)	Access; Interaction; Response; Results	32	<p>Assess students' perceptions about the Web-Based Learning Environment Instrument and the use of the web as a learning environment.</p> <p>The instrument has four dimensions (eight items per dimension), assessing the following aspects: access to online materials; interaction and participation in online learning; perceptions of students who learn in this environment; and the learning outcome and student performance in the online learning environment.</p> <p>Items are assessed on a 5-point scale, as follows: 1- Almost Never; 2- Rarely; 3- Sometimes; 4- Often; and 5- Almost always.</p>
Adult Classroom Environment Scale (ACES) (Darkenwald & Valentine, 1986)	Involvement; Affiliation; Teacher Support; Task Orientation; Personal Goal Attainment; Organization and Clarity; Student Influence	49	<p>Assess the climate/social environment of the learning environment in adult education, considering effective teacher behaviors or teaching styles.</p> <p>The use of this instrument has several implications, such as: identifying discrepancies between students and teachers' perceptions of the existing social environments in the classroom; finding ways to involve adult students in efforts to improve the overall quality of the classroom environment and; motivating teachers to use student feedback in order to improve teaching and learning transactions.</p> <p>The scale consists of seven dimensions (with seven items each), assessed using a 4-point Likert-type scale, where 4- I totally agree and 1- I totally disagree.</p>

<p>Cultural Learning Environment Inventory (CLEQ) (Fisher & Waldrup, 1999)</p>	<p>Equity; Collaboration; Deference; Competition; Teacher authority; Modelling; Congruence</p>	<p>35</p>	<p>Assess culturally sensitive factors in science students' learning environments and examine associations among these factors, student performance in inquiry skills, students' attitudes toward science, and teacher-student interactions. The scale consists of seven dimensions (with five items each) and presents a five-point scale with assessment alternatives ranging from 1- agree to 5- disagree.</p>
<p>Outcomes-Based Learning Environment Questionnaire (OBLEQ) (Seopa, Laugsch, Aldridge, & Fraser, 2003)</p>	<p>Involvement; Investigation; Cooperation; Equity; Differentiation; Personal Relevance; Responsibility for Learning</p>	<p>56</p>	<p>Assess students' perceptions about the classroom learning environment as a means of monitoring and guiding changes toward results-based education. The instrument has seven dimensions in its structure, with eight items in each one. It was developed based on existing instruments used in the field of learning environment studies, such as: What Is Happening In this Class? (WIHIC); Constructivist Learning Environment Survey (CLES); and Individualized Classroom Environment Questionnaire (ICEQ). It presents a five-point frequency scale with the following assessment alternatives: Always; Often; Sometimes; Rarely; and Never.</p>
<p>Online Learning Environment Survey (OLES) (Trinidad, Aldridge, & Fraser, 2005)</p>	<p>Computer usage; Teacher Support; Student interaction and collaboration; Personal relevance; Authentic learning; Student autonomy; Equity; Enjoyment; Asynchronicity</p>	<p>54</p>	<p>Provide teachers using e-learning with a mechanism to reflect on the online learning environment based on the results obtained from students' feedback. OLES was developed from five existing learning environment assessment instruments: (1) What Is Happening In this Class? (WIHIC); (2) Constructivist Learning Environment Survey (CLES); (3) Distance Education Learning Environments Survey (DELES); (4) Technology-Rich Outcomes-Focused Learning Environment Instrument (TROFLEI); and (5) Test of Science-Related Attitudes (TSRA). In addition, OLES features two formats in which students can rate the actual learning environment considering their experiences on the course, compared to the preferred learning environment, using a 5-point rating scale (almost never, rarely, sometimes, often and almost always).</p>
<p>Technology Integrated Classroom Inventory (TICI) (Wu, Chang, & Guo, 2009)</p>	<p>Technological enrichment; Inquiry learning; Equity & friendliness; Student cohesiveness; Understanding & encouragement; Competition & efficacy; Audiovisual environment; Order</p>	<p>49</p>	<p>Assess students and teachers' perception about the technology-integrated learning environment, thus considering the prominent technological impacts on the learning process. In its constitution, the TICI involves the use of existing assessment instruments oriented to the use of technology in teaching-learning, including Constructivist Multimedia Learning Environment Survey (CMLES); New Classroom Environment Instrument (NCEI); and Technology-rich Outcomes-focused Learning Environment Inventory (TROFLEI), providing different views of scales related to the use of technology in the learning environment. The TICI presents as assessment alternatives a five-point Likert-type scale ranging from 1- almost never to 5- almost always.</p>

Constructivist Internet-based Learning Environment Survey (CILES) (Chuang & Tsai, 2005)	Student Negotiation; Inquiry Learning; Reflective Thinking; Relevance; Ease of use; Challenge	30	Assess students' perceptions of Internet-based constructivist learning environments. CILES has items that assess the level of agreement/disagreement on a five-point Likert scale, and it was based on the Constructivist Multimedia Learning Environment Survey (CMLES) instrument.
Connected Classroom Climate Inventory (CCC) (Dwyer, Bingham, Carlson, Prisbell, Cruz, & Fus, 2004)	Unidimensional instrument	18	Assess students' perceptions about the classroom climate in higher education, as well as student connection, communication, and cooperation in the university classroom. The CCCI presents as assessment alternatives a 5-point Likert-type scale, considering the agreement or disagreement of each statement (1- Strongly disagree to 5- Strongly agree).

The scales presented address the classroom environment, and assess how students and teachers perceive this LE. In general, it is possible to identify, in these instruments, aspects that investigate whether a classroom is student-centered, whether students actively behave or just sit and listen to the teacher (as passive students), whether students work together and contribute to the learning of colleagues or whether they work alone; also whether the teacher is supportive and accessible and whether students participate in the choice of teaching methods and assessment and, at last, whether the differences in students' work interests are allowed by the teacher (Fraser, 2012, 2015).

Table 7, below, shows the ranking of the five most cited instruments, the number of articles that mention these instruments according to the records selected in the SLR, and the relative frequency considering a total of 94 occurrences. The sum of citations of the articles indicated in the third column of the Table 7 is greater than the total number of occurrences, as several articles refer to more than one instrument.

Table 7. Ranking of the most cited learning environment assessment instruments in SLR articles

Ranking	Most cited instruments	N° of articles that cited the instruments	Relative frequency
1	What Is Happening In this Class? (WIHIC)	36	38%
2	Constructivist Learning Environment Survey (CLES)	32	34%
3	Classroom Environment Scale (CES)	28	30%
4	Learning Environment Inventory (LEI)	15	16%
5	My Class Inventory (MCI)	12	13%

The most highlighted and cited instrument in SLR articles (38% of the total) was What Is Happening In this Class? (WIHIC), considered one of the most significant instruments in the field of LE studies, which assesses students' perception about their individual role in classroom (Dorman, 2008). In addition, this instrument provides an assessment of the classroom based on students' perceptions and feelings, and understands the relationship between teachers and students for meaningful learning (Yufiarti & Rusbita, 2017). In Brazil, the WIHIC scale was translated, adapted and validated by Chagas Júnior (2018) in his master's thesis.

Figure 2 corroborates the data revealed in Table 6, and illustrates the most used LE assessment instruments in the review articles.

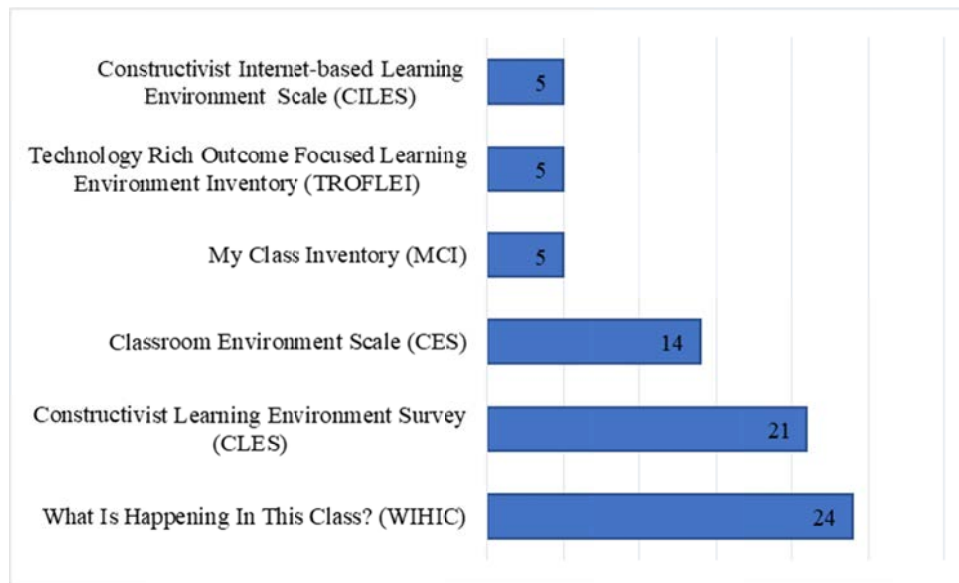


Figure 2. Most used learning environment instruments in SLR articles

The What Is Happening In this Class? (WIHIC), Constructivist Learning Environment Survey (CLES) and Classroom Environment Scale (CES) scales were the instruments highlighted in the surveys carried out in the assessment of LE according to the SLR records. These instruments reveal their relevance for the field of LE studies, and are part of the historical context of research growth over the years, in addition to being considered subsidies for the development of various questionnaires on the subject.

Considering the presentation of the results inherent to the main LE assessment instruments identified in the literature according to the SLR method, it is possible to understand that the interaction of individuals with the environment takes place based on several assumptions that involve this training space and the importance of considering that this environment is not one-dimensional, but it is characterized by multidimensional links that are decisive for experiences in the teaching-learning process.

5. Conclusions

This article mapped the main assessment instruments for LE based on a systematic literature review. The study results revealed 20 instruments published between 1974 (Moos & Trickett, 1974) and 2009 (Wu, Chang, & Guo, 2009) that can be used by researchers and practitioners in the educational context. This indicates a practical contribution of this study, since many researchers will be able to use the analysis of instruments to assess what best suits their objective, context and target audience to be analyzed.

From a systematic analysis of the literature, we found that several instruments are based on constructivist and experiential epistemological bases, which denotes a perspective of assessing the role of the LE in the education of a more autonomous and independent student.

Aspects related to the social and psychological environment are also evidenced in the analyzed instruments, which demonstrates researchers' concern to capture students' perception of how they assess the actual or ideal LE, as well as the behaviors and interpersonal relationships among students and between students and teachers, besides the way students engage and interact in the classroom and develop research skills.

Some instruments also stood out in the assessment of the technological LE with the aim of capturing students' perceptions about access to materials, multimedia programs, interaction and participation in online learning, feedback, the impacts of technology on reflective and collaborative learning, as well as student engagement. With the pandemic, elements from the physical, psychological and social environment were incorporated into the technological environment. Videoconferencing platforms, in particular, are characterized as a socio-material representation of the classroom, which signals the need for studies, in hybrid learning environments, to be analyzed in a more accurate way, for instance, incorporating objective and subjective elements, emotional and social experiences, also considering that the students' physical space at home or work, mainly, impacts not only their learning, but also the teacher's performance, which corroborates for the institution to not have control over the physical space where students are interacting through a videoconference platform.

The twenty instruments analyzed cover 85 different categories, but the influence of the What Is Happening In this Class? (WIHIC) scale is evident, since six of the seven dimensions of this instrument integrate four or five of the instruments indicated in Figure 5, revealing the contribution of the article written by Fraser, Fisher and McRobbie (1996), that seeks to contribute to the development of quantitative studies for the assessment of LE.

An analysis of the dimensions that comprise the instrument reveals the complexity and contribution of the pedagogical dimension of the LE. The teacher must plan the teaching action with the purpose of stimulating greater engagement and improving student performance, which requires interactive and innovative teaching and learning strategies. The planning of teaching action is configured as one of the critical factors in the LE.

Most of the quantitative studies that used the instruments to assess LE took place between 2011 and 2020 (54.2%). However, there was no publication with a new instrument for the assessment of LE during this period.

By analyzing all instruments together, this study reveals the potential of developing an instrument that adopts a multidimensional perspective of LE proposed by Silva, Silva, and Coelho (2019) from a study carried out with graduate students using a qualitative approach. It is evident the presence of social, psychological, technological and pedagogical dimensions in the instruments that, when analyzed together on the same scale, could broaden the analysis of the context, actors and objective and subjective aspects that influence learning in educational environments. Thus, one of the practical implications of this study involves the development of a multidimensional scale for assessing LE.

As limitations, we highlight the use of only the Web of Science database, so that other assessment instruments present in articles incorporated in other databases were not included in this study.

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