

# The Chemistry Instrument Review and Assessment Library (CHIRAL): A New Resource for the Chemistry Education Community

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Cite This: *J. Chem. Educ.* 2023, 100, 1455–1459



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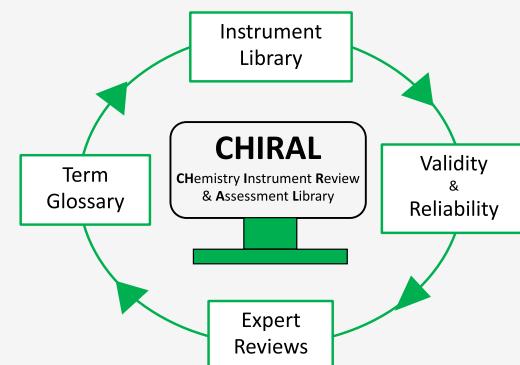
**ABSTRACT:** To facilitate the chemistry education community in locating and evaluating published assessment instruments, the Chemistry Instrument Review and Assessment Library (CHIRAL) encompasses a number of resources. First and foremost, CHIRAL contains a catalog of over 500 assessment instruments that is easily searchable, allowing for the identification of instruments within a given domain, topic, or format. Each instrument listing in CHIRAL includes metadata (intended population, language, number of items, etc.), a bibliography of studies that have used the instrument and reported evidence for validity and reliability, a catalog of the reported evidence, a panel review report providing a synthesis of the reported validity and reliability evidence (for select instruments), and a glossary of common terms used in psychometric evaluations. This paper presents the purpose of CHIRAL and provides details about its development.

**KEYWORDS:** High School, Introductory, First-Year Undergraduate, General, Chemical Education Research, Testing, Assessment

## INTRODUCTION

Assessment instruments are used by educators and researchers to gather data about students and the learning environments in which they exist. Self-report instruments are used to measure student-related constructs within the cognitive,<sup>1,2</sup> affective,<sup>3,4</sup> and behavioral domains,<sup>5,6</sup> while observation protocols are used to capture the structure of the learning environment itself.<sup>7,8</sup> These types of tools have been used to provide a range of data to support the impacts of classroom and laboratory teaching practices.<sup>9–11</sup> The development and publishing of assessment instruments within chemistry education spans over 50 years of the literature, and the community is constantly searching for ways to improve the robustness of evidence that support these assessments. Currently, our team has identified over 500 different assessment instruments within the chemistry education literature, with new and modified instruments being added each year. As these tools are published across many years and in various journals, finding an assessment instrument to use for a given study can often require time-intensive literature searches.

When selecting an assessment instrument for use in a study or classroom, a researcher or educator needs to be able to gather insights about its intended purpose, the population(s) and/or setting(s) it has been used within, and the evidence that supports the validity and reliability of the data that has been collected.<sup>12–14</sup> These details inform decisions about how well-aligned the instrument is for their intended purpose and what additional evidence of validity and reliability might need to be further supported. While these details are found within the



studies published by the instrument developer, additional details and evidence may also be found when an instrument is used by others or undergoes further psychometric testing. Therefore, the information about a given assessment instrument may appear across numerous publications, further increasing the time required to make a decision about the instrument's implementation based on the most comprehensive information possible. Lastly, the chemistry education community continues to grow in its use of different frameworks/models for assessment instrument development and in the research methods used to evaluate the data generated by these tools.<sup>14–19</sup> Additionally, the terminology used when describing validity and reliability has evolved and has not always been standardized, which complicates the review and synthesis of studies published across time.<sup>18,20</sup> Up to now, no coordinated effort has been made in the chemistry education community to develop a centralized list of assessment instruments or to compile the evidence supporting the administration of these tools.

Received: August 5, 2022

Revised: November 17, 2022

Published: April 3, 2023



## ■ WHAT IS CHIRAL?

The Chemistry Instrument Review and Assessment Library (CHIRAL) is a centralized resource for locating assessment instruments designed for and used within the chemistry education community. In addition to providing a comprehensive list of available instruments, CHIRAL catalogs metadata for each instrument (intended population, language, number of items, etc.), a bibliography of studies that have used each instrument, an indication if evidence for validity and reliability has been reported in any study using the instrument, a panel review providing a synthesis of the validity and reliability evidence (not available for all instruments), and a glossary of common terms used in psychometric evaluations. Lastly, CHIRAL contains a compilation of other portals where interested users can find assessment instruments from other fields including STEM and psychology.

The CHIRAL site (<https://chiral.chemedx.org>) is hosted in collaboration with the Chemical Education Xchange (ChemEd X), an American Chemical Society (ACS) community resource established in 2012 and funded by the Division of Chemical Education (ACS DivCHED). Support for development of the Chemistry Instrument Review and Assessment Library (CHIRAL) comes from the National Science Foundation's Improving Undergraduate STEM Education (IUSE) program under grant numbers 1915424, 1914996, and 1915343.

## ■ HOW INSTRUMENTS ARE IDENTIFIED AND CATALOGUED

The CHIRAL database was initially populated from lists of instruments identified by other researchers in book chapters,<sup>19</sup> on websites,<sup>21</sup> and in instrument development dissertation chapters,<sup>22</sup> as they represented assessments that were well-known and used in the field. For these initial instruments, the publication where the instrument was first reported was added to the CHIRAL database. From this initial instrument publication, forward and backward references were examined to create a complete record of situations where the instrument had been used previously or earlier instruments that informed its development. While this initial protocol allowed the CHIRAL team to capture the rich history of many popular instruments in the chemistry education literature, it did not provide a systematic survey of all known instruments. We have refined the database population methodology to include systematically reading through full issues of journals relevant to the field of chemistry education and identifying any additional instruments that appear in publication to ensure the CHIRAL database ultimately becomes a comprehensive catalog. To date, the database contains information for all instruments appearing in *Chemistry Education Research and Practice* from 2010 to 2021. Ongoing work is prioritizing the comprehensive inclusion of all instruments from the *Journal of Chemical Education* from the same time frame. Further data entry will work both forward and backward in time to cover as much of the chemistry education literature as possible.

Importantly, the CHIRAL database contains information on an instrument from publications where the instrument is first developed/introduced, used, modified, or evaluated. Due to the fact that instruments themselves are not directly cited, only the publications they appear in, identifying publications for inclusion in the database requires CHIRAL research team members to read all citations of an original instrument development publication. This process is to gauge if the

publication citation includes use, modification, and/or evaluation of the instrument. Only then is the new publication added to the CHIRAL database. Therefore, the recorded references in CHIRAL are not just a list of citing publications but publications where the instrument has been used for data collection. A limitation of this approach is that it assumes authors are citing the original publications where an instrument appears, and some instrument usages may be missed if the original development publication is not cited. By recording this information, CHIRAL users can quickly see which references may be most helpful to their intended purposes and the degree to which an instrument may meet pedagogical and/or research goals. In addition to recording basic information for an instrument (e.g., authors, title, year published, topic, number of items, item format, use populations) the CHIRAL coding team also identifies relevant data-quality evidence that appears at the intersection of publication and instrument. These data-quality evidence codes represent different ways the field has addressed the validity and reliability of instrument data<sup>18,20</sup> using methods such as expert review, response process interviews, factor analysis, test-retest reliability, and single-administration reliability coefficients. This information is extracted from the publications by a team of researchers trained on the definitions and coding schemes developed for the CHIRAL project. Information is reviewed by secondary coders to ensure agreement prior to publication on the CHIRAL website.

## ■ PANEL REVIEWS OF EVIDENCE

To further assist the chemistry education community in assimilating the information that supports a given assessment instrument, CHIRAL provides panel reviews of the published studies surrounding an instrument and synthesizes their findings in a summary report attached to the instrument record. These reviews provide users with a comprehensive overview of the evidence presented in the literature. Panel members are recruited from the chemistry education community and have prior experience in assessment instrument development and evaluation and/or the research methods used in psychometric testing. Panel members individually review each study surrounding an instrument and catalog details (i.e., settings, populations) and the evidence supporting the data generated by the instrument. Panelists then meet to discuss the scope and quality of the published evidence and generate a panel review of their findings. The intent of a review is 2-fold. First, each provides a summary, which is a synthesis of the available evidence in language that is aligned with the *Standards for Educational and Psychological Testing*.<sup>20</sup> Second, panels provide recommendations for use of the instrument and suggestions for ongoing or additional evidence to support the intended purpose of an instrument.

## ■ CHIRAL WEBSITE

Users can access all the information gathered by the CHIRAL team via the website (<https://chiral.chemedx.org>). The primary function of the website is accessed by navigating to the Browse/Search card from the home page which allows users to find assessments by keyword or filter by categories such as response format, topic, intended population, or domain. Once an assessment instrument is identified, users can view five tabs for every instrument that organize all information the CHIRAL team has assembled for a specific instrument. Additionally, the CHIRAL home page contains links to the glossary, a place to



## Search CHIRAL

Use the search and sort features to enter keywords (e.g. "stoichiometry") and sort results (e.g. by Population). Alternatively, you can browse instruments within categories using the checkboxes on the right-hand side of the screen.

Displaying results 1 - 11 of 11

Use the boxes below to search and sort:

[Reset](#)

\*\*\* Title Ascending 25 

<a href="#">Chemistry Laboratory Anxiety Instrument (CLAI)</a>			
Published: 1999	Population: Students, Undergraduate	Format: Response Scale	Questions: 30 
<a href="#">Derived Chemistry Anxiety Rating Scale (DCARS)</a>			
Published: 1996	Population: Students, Undergraduate	Format: Response Scale	Questions: 36 
<a href="#">Derived Chemistry Anxiety Rating Scale (Turkish) (Senocak &amp; Baloglu, 2014)</a> DCARS (Turkish) (Senocak & Baloglu, 2014)			
Published: 2014	Population: Students, Undergraduate	Format: Response Scale	Questions: 36
<a href="#">Modified Chemistry Laboratory Anxiety Instrument</a>			
Published: 2019	Population: Students, Undergraduate	Format: Response Scale	Questions: 4
<a href="#">Motivated Strategies For Learning Questionnaire (Yalcinkaya &amp; Boz, 2015)</a> MSLQ (Yalcinkaya & Boz, 2015)			

**Search Results**

- Topic: Anxiety
- 11 results found
- [\(-\) Anxiety \(11\)](#)

**Domain**

- [Affective \(11\)](#)

**Topic**

- [\(-\) Anxiety \(11\)](#)

**Reviewed by CHIRAL panel**

- [No \(9\)](#)
- [Yes \(2\)](#)

**Population**

- [Adults \(2\)](#)
- [Graduate \(2\)](#)
- [High School \(2\)](#)

Figure 1. Example of filtering all assessments tagged as measuring “Anxiety” by selecting from the Topic list.



## Derived Chemistry Anxiety Rating Scale

DCARS

OVERVIEW	EVIDENCE	REVIEW	VERSIONS	CITATIONS												
Listed below is general information about the instrument.																
<p><b>Summary</b></p> <table border="1"> <tbody> <tr> <td>Original author(s)</td> <td>Eddy, R.M.</td> </tr> <tr> <td>Original publication</td> <td>Eddy, R. M. (1996). Chemophobia in the college classroom: Extent, sources, and student characteristics (Doctoral dissertation, University of Pittsburgh).</td> </tr> <tr> <td>Year original instrument was published</td> <td>1996</td> </tr> </tbody> </table>					Original author(s)	Eddy, R.M.	Original publication	Eddy, R. M. (1996). Chemophobia in the college classroom: Extent, sources, and student characteristics (Doctoral dissertation, University of Pittsburgh).	Year original instrument was published	1996						
Original author(s)	Eddy, R.M.															
Original publication	Eddy, R. M. (1996). Chemophobia in the college classroom: Extent, sources, and student characteristics (Doctoral dissertation, University of Pittsburgh).															
Year original instrument was published	1996															
<p><b>Inventory</b></p> <table border="1"> <tbody> <tr> <td>Number of items</td> <td>36</td> </tr> <tr> <td>Number of versions/translations</td> <td>1</td> </tr> <tr> <td>Cited implementations</td> <td>3</td> </tr> <tr> <td>Language</td> <td>English</td> </tr> <tr> <td>Country</td> <td>United States</td> </tr> <tr> <td>Format</td> <td>Response Scale</td> </tr> </tbody> </table>					Number of items	36	Number of versions/translations	1	Cited implementations	3	Language	English	Country	United States	Format	Response Scale
Number of items	36															
Number of versions/translations	1															
Cited implementations	3															
Language	English															
Country	United States															
Format	Response Scale															

Figure 2. Five primary tabs (Overview, Evidence, Review, Versions, and Citations) available for every assessment on CHIRAL.

submit feedback for the CHIRAL team to consider, more information about the CHIRAL team and process, and a link to resources similar to CHIRAL.

As a CHIRAL use example, suppose a researcher or instructor has a desire to measure the anxiety students face in their course.

Filtering results to include only assessments tagged as measuring “anxiety” (by clicking “Anxiety” under the Topic list) reveals 11 assessments, two of which have panel reviews (Figure 1). Similar results can be found by typing “anxiety” as a search term. However, sometimes an assessment may be tagged as measuring

anxiety without actually using that word in a searchable field such as the instrument title. For any of the 11 displayed anxiety assessment, users can then view the overview of an assessment, the evidence reported from the literature, a panel review (if available), any related assessments, and citations that report using the assessment (Figure 2).

## ■ COMMUNITY INVOLVEMENT IN CHIRAL

In addition to members of the chemistry education community serving as review panelists and advisory board members, CHIRAL is designed to be a resource for the community. Therefore, we seek input from the community to help improve and maintain it. The CHIRAL team has done its best to compile the assessment instruments being used within our field. However, there are reasons why you may not find a specific instrument on CHIRAL. First, we may have missed it in our searches through the literature. Additionally, even if we have found an instrument in the literature, we have more instruments in our database than appear on the CHIRAL site, this is due to a backlog of instrument coding. Regardless of the reason for an instrument not appearing on CHIRAL, we encourage users to contact us using the "CHIRAL Feedback" form to let us know what instruments they would like to see. In addition to helping us keep the list of instruments up to date, the same form can also be used for the community to provide feedback on all aspects of CHIRAL and the information it provides. We look forward to incorporating feedback and developing a tool that benefits the entire chemistry education community.

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### Funding

This material is based upon work supported by the National Science Foundation under Grant No. 1915424, 1914996, and 1915343. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

### Notes

The authors declare no competing financial interest.

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