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Engaging classroom observation: A brief measure of active learning in the college classroom

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Abstract

The purpose of this study was to develop a valid, reliable, and brief measure of active learning in college classrooms that is cheap and easy to complete and yields results that faculty can easily use to inform their development as instructors. Initial construct and face validity was achieved by modifying existing instruments and creating a draft of a brief measure of active learning for external expert review. Following the suggested revisions, the engaging classroom observation was then piloted and revised as necessary. Reliability was tested and measures of internal consistency and interrater reliability were acceptable. A principal component analysis showed two components that were moderately correlated, which indicated the potential they could be combined. An Exploratory Factor Analysis confirmed the instrument is measuring one factor, which we propose as active learning. This study is significant because it offers a brief instrument based on students' perceptions that can be used formatively by faculty.

Keywords

active learning, brief measure of active learning, instrument, student perceptions, validity study

Setting the scene: Active learning in the college classroom

Bonwell and Eison (1991) define active learning as "instructional activities that involve students in doing things and thinking about what they are doing" (p. iii). On the basis of evidence of student preference for and increased success in courses that make use of active learning as opposed to traditional, lecture-based instructional techniques, they recommend promoting the use of active

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learning in college classrooms. In the past four decades, the evidence has only mounted in favor of this proposition.

The use of active learning techniques in the classroom has been shown to have clear benefits for undergraduate students (Prince, 2004). In particular, one meta-study showed that students in classrooms where instructors use active learning perform better on formal assessments (e.g. exams) and are less likely to fail the course than students in classrooms where instructors lecture (Freeman, et al., 2014). Though these findings are most robust in the STEM context, there is reason to think they apply as well to the humanities and social sciences. In addition to descriptive accounts of student success in humanities and social science courses that employ active learning (Waitkus, 2006), there have been studies documenting successes similar to those found in STEM courses (McCarthy & Anderson, 2000). And the evidence continues to mount in a number of contexts of pressing concern. For instance, there is evidence that incorporating active learning techniques was beneficial in online STEM instruction in the pandemic context (Rincon-Flores & Santos-Guevara, 2021; Rossi et al., 2021) and reduces the desire to plagiarize (du Rocher, 2020), an issue of special concern given recent advances in generative artificial intelligence. Moreover, general confidence in the efficacy of active and student-centered instructional strategies is bolstered by their foundation in constructivist learning theory (Narayan et al., 2013; Phillips, 1995). We are at a point where concerns are being raised about the continued use of lecturing as an instructional method or even as a control in future studies testing the efficacy of active learning (Freeman et al., 2014).

Though there has been a great deal of scholarly attention paid to documenting the advantages of teaching in an active and student-centered manner, the practical issue remains of how to heed Bonwell and Eison's (1991) recommendation to recognize and reward faculty who do so. The aim of this paper is to contribute to this goal by introducing a teaching observation protocol developed at a regional state university an hour outside of one of America's largest and most diverse cities to measure the frequency and breadth of faculty use of evidence-based, high-impact practices in higher education classrooms of any size or discipline. The Engaging Classrooms Observation (ECO) aims at providing formative feedback to faculty in an easily digestible format and is deployable in any of three ways: as a coded observation of a classroom recording, as a student survey, or as a peer observation. This article reports initial results about the reliability and validity of the first two modes of use. The hope is that further research will contribute to a more complete understanding of ECO's usefulness as a tool for measuring the use of active and student-centered instructional strategies in the higher education context.

Barriers to the use of active learning and the role of a teaching observation tool

Bonwell and Eison (1991) identify several barriers to increased use of active learning in college classrooms. One set of barriers has to do with faculty perceptions of risks and rewards and their influence on classroom planning (Bonwell & Eison, 1991, pp. 76–78). Faculty often fear that students will not participate in the activities planned or that they will not learn all necessary content; they often also fear losing control of the classroom or appearing unskilled or unorthodox in their teaching. Among the tools they offer in response is a survey asking faculty to reflect on their teaching methods, both now and in the future (Bonwell & Eison, 1991, p. 84). Faculty are asked to indicate whether 22 statements about teaching method (e.g. "I lectured the whole period" or "I had students engage in a brainstorming activity") applied to the last time they were in the classroom and will apply to the next time they are in the classroom. This survey is supposed to help faculty gauge their familiarity and comfort with various active learning strategies in order to plan how they will increase implementation of them in the future.

Another set of barriers is systemic. Administrators have not properly incentivized the changes necessary to follow the evidence-based recommendation that active learning be widely incorporated in classrooms of all sizes and disciplines (Bonwell & Eison, 1991, p. 73), and adequate faculty-led support systems have not been developed (Bonwell & Eison, 1991, p. 85). Though Bonwell and Eison (1991) do not explicitly link their survey on teaching methods to reward structures and support systems, this is one potential application. Indeed, the intended applications of the survey discussed here, ECO, include identification of the prevalence of use of active learning techniques in the classroom by particular instructors, within particular disciplines, and campus-wide. This data may then be used in various ways to tackle the aforementioned barriers—for example, to provide formative feedback to faculty for the purposes of professional development and evaluation; to assess the impact of faculty-led trainings and support systems; and to communicate these impacts to administrators in the context of developing appropriate incentive structures.

There exist teaching observation tools to assess the use of active learning techniques in the classroom that do not rely on self-reports, but they tend to have been designed with a particular focus in mind. The Active Learning Classroom Observation Tool (ALCOT), for instance, was designed specifically for observation of teaching in "active learning classrooms," instructional spaces designed to facilitate the use of such teaching strategies (Birdwell et al., 2016; Birdwell & Harris, 2022). Other tools, such as the Practical Observation Rubric to Assess Active Learning (PORTAAL) (Eddy et al., 2015) and the Teaching Dimensions Observation Protocol (TDOP) (Hora, 2015; Hora & Ferrare, 2014) were designed to measure the types and prevalence of active learning instructional strategies in college STEM classrooms. There is room for improvement, and especially, for the development of a tool designed to measure active learning in a broad range of contexts. We here focus on TDOP, as it was an inspiration for ECO, and explain why and in what ways ECO is an improvement.

TDOP 2.0 (Hora & Ferrare, 2014) is a freely available tool available online for the documentation of instructional practice, as opposed to quality, and its reliability and validity have been extensively verified. TDOP's intended uses include documenting the use of various instructional strategies, supporting professional development, and assessing the effectiveness of interventions (CCHER, n.d.). Notably, the TDOP is not a self-report protocol. It typically involves filming periods of classroom instruction and having trained, independent raters code the film at regular intervals to provide a holistic picture of what was happening in the classroom. Thus, it differs from the Bonwell and Eison (1991) survey in ways that may make it more suitable for objective data-gathering in the service of the aforementioned goals.

The TDOP 2.0 has many desirable features, such as being adaptable, web-based, and free. But it also presents some barriers to successfully meeting its intended uses. Its comprehensiveness results in lengthy, detailed reports that typically need to be deciphered by a trained individual when being presented to faculty or administrators. The TDOP is also resource intensive. In addition to someone to discuss the report, it requires the availability of filming equipment, staff to facilitate filming, and a team of trained coders. It would be good to have a teaching observation tool that is at once objective and cheap and easy to use. ECO is intended to satisfy this need.

Rationale for this study

Instructional techniques have not yet caught up with the evidence that active learning in the college classroom improves student success (Freeman et al., 2014; Stains et al., 2018). One tool that may help to overcome remaining barriers is a teaching observation tool that is cheap, informative, and user-friendly. That's what we set out to develop. ECO is comprised of 15 components, the frequency of each of which is scored on a 5-point scale from "Never" to "Always" (Supplemental

Table 1. Student demographics.

	Total	Men	Women
Total	21,612	7,676	13,936
American Indian/native American	132	47	85
Asian	544	212	332
Black/African American	3,493	1,165	2,328
Hispanic	5,638	1,769	3,869
Native Hawaiian or other Pacific Islander	27	12	15
White	10,425	3,917	6,508
Two more	711	272	439
Race un-known	360	138	222

Appendix). Though TDOP was an initial inspiration, the 15 components of ECO were arrived at based on the literature on evidence-based best practices.

In addition to having the benefit of fewer components than TDOP, ECO is also deployable in three compatible ways. An instructor's class may be rated by a peer, by their students, or by trained coders based on a single filmed class session. We will here report on the reliability and validity of ECO using these last two methods. The investigation was guided by the following research questions: Is ECO a valid and reliable measures of active learning in the college classroom? Do professors believe the measure is useful?

Method

To answer the research questions, the current study investigated the validity and reliability evidence of ECO. The study was conducted at the researchers' university that serves 21,612 students. Table 1 summarizes the student population by gender and ethnicity. Of those students, 222 student responses were included in the Principal Component Analysis (PCA) and 332 were included in the Confirmatory Factor Analysis (CFA). No specific demographic data were collected from the participants as the validation of the instrument was anonymous.

Development of ECO

Construct validity. ECO was developed based on some of the constructs from the TDOP (Hora & Ferrare, 2014), including teaching methods, student-teacher dialog, instructional technology, potential student cognitive engagement, and pedagogical strategies. The number of items for the dimensions were reduced and reworded to solicit an interval response ranging from never observed to always observed (see Supplemental Appendix for ECO).

Content and face validity. The office of Engaging Classrooms (QEP) and the office of Professional and Academic Center for Excellence (PACE) at the researchers' university collaborated on an initial draft of ECO. It went through several iterations and was then sent to eight experts in the field at four different universities for feedback. The feedback was incorporated, and the instrument was field tested with one classroom (n = 16) for feedback and a preliminary review of the results. After initial field testing, the 17-item instrument was reduced to 15 as two items did not yield meaningful information regarding active learning in classrooms. Feedback from the team and professors indicated that ECO was a valid measure of active learning in the college classroom.

Procedures

The final items were added to a Qualtrics survey. For use as a student survey, it was decided to distribute the survey in the middle of the semester for a few reasons. First, it allows students to attend the course for about 7 weeks, and thus have plenty of experience learning in class. Next, it allows the professor to use the results formatively and adjust their teaching for the remainder of the course if necessary. Finally, students are typically overwhelmed with surveys at the end of the semester, and therefore the researchers believed the response rates would be higher.

The link to the survey was sent to the professor with a request they distribute it to their students. The survey was anonymous and only asked participants the name of their course and instructor, and the next page contained the ECO questions. It was estimated to take approximately 5 min to complete.

Data analysis

After data collection, the reliability was assessed first by examining the internal consistency and interrater reliability. Next, the underlying structures were examined. First, a PCA was used to gauge the possibility of multiple factors. Following the PCA, a CFA was conducted with the goal of narrowing the measure to a single factor—active learning.

Results

The PCA, analyzed with SPSS v27, revealed two factors; they were moderately correlated, and the second factor's eigen value was close to 1. Therefore, the CFA was conducted using the lavaan package in RStudio to examine if the model would fit into a single factor.

Reliability

Internal consistency. The measure was used in 18 different courses resulting in 332 student responses. The internal consistency was measured using Cronbach's Alpha (α), which is a coefficient that measures the reliability of a survey or instrument. Using the 332 student responses on the 15 items, the internal consistency of the instrument was found to be excellent, $\alpha = .93$.

Interrater reliability. Two graduate assistants were trained to assess videos of faculty teaching and administer the assessment. Each watched the same five video recordings of teaching episodes ranging from 50 to 90 min, and independently rated the episode with ECO, for a total of 75 ratings for each rater totaling 150 observed data points. First, the reliability was assessed and found to have excellent internal consistency, $\alpha = .87$. There were no significant differences within raters between items (Table 2). The intraclass coefficient (ICC) for single measures was strong and the average measures ICC was considered very strong (Table 3).

Principal component analysis

A principal component analysis (PCA) was conducted to explore the factor structures of ECO. First, the KMO test for sampling adequacy was 0.94 and Bartlett's test of sphericity was significant ($p < .001$) indicating that data were suitable for PCA. It is recommended that two different samples be used for the PCA and Confirmatory Factor Analysis (CFA), and thus the number of responses will differ for each analysis. Minimum sample size was also met as 222 is greater than the 15 components multiplied by 10. Two factors emerged with eigenvalues greater than 1.0 (Figure 1), and the total variance explained of both factors is summarized in Table 4.

Table 2. ANOVA with Friedman's test.

	SS	*df*	*MS*	χ^2	*p*
Between people	272.573	74	3.68		
Within people					
Between items	0.24[a]	1	0.24	0.49	.49
Residual	36.76	74	0.50		
Total	37.00	75	0.49		
Total	309.57	149	2.08		

[a]Kendall's coefficient of concordance $W = .001$.

Table 3. Intraclass correlation coefficient.

	ICC	95% CI		*F* test with true value 0			
		Lower	Upper	Value	df_1	df_2	*p*
Single measures	.76	.65	.84	7.42	74	74	<.001
Average measures	.87	.79	.92	7.42	74	74	<.001

Note. ICC, .20 = weak; .40 = moderate; .60 = strong; .80 = very strong.

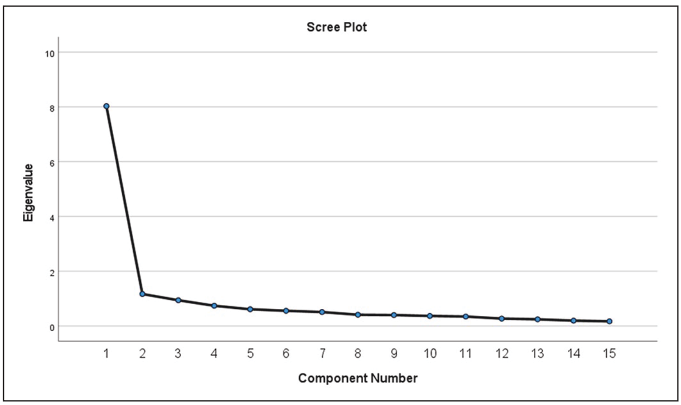

Figure 1. Scree plot.

Table 4. Total variance explained.

Component	Initial eigenvalues		Rotation sums of squared loadings	
	% of variance	Cumulative %	% of variance	Cumulative %
1	53.54	53.54	39.72	39.72
2	7.80	61.34	21.62	61.34

The PCA used varimax rotation, and the component loadings are in Table 5. To assess the internal consistency of the components, Cronbach's α was computed for the two components. Factor was found to have excellent reliability ($\alpha = .93$), and was considered good ($\alpha = .75$).

Table5. Rotatedcomponentmatrix($N = 222$).

Componentloading	1	2	Communality
Professorengagesstudentsinguidedpracticeofconceptsorskills	0.81	0.29	0.74
Studentsareactivelylearning	0.81	0.31	0.75
Overall,theclasswasstudent-centered	0.78	0.29	0.70
Professorappearstospendanappropriateamountoftimeintheir instructionalapproaches(i.e.lectures,demonstration,andgroupwork)	0.77	0.37	0.73
Overall,theprofessoreffectivelytaughtthecourseMaterial	0.76	0.38	0.72
ProfessorinteractswithstudentsduringlecturesorDemonstrations	0.75	0.29	0.65
Whenusingmultimedia,professorusesiteffectively	0.73	0.13	0.56
Professorencouragesstudentstoaskquestionsforclarificationand comprehension	0.64	0.30	0.50
Studentspayattention	0.63	0.10	0.41
Professorusesappropriatemethodstoassessstudents'learning,either formallyorinformally	0.57	0.50	0.58
Professorconnectsinstructionandconceptstousesbeyondthe classroom	0.55	0.55	0.60
Studentsareprovidedwithtasksordilemmaswheretheoutcomeis open-endedratherthanfixed	0.21	0.80	0.68
Professorposesopen-endedquestionsandgivesadequatetimefor responses	0.40	0.67	0.61
Professorinteractswithsmallgroupsorindividuals	0.35	0.66	0.56
Studentsareprovidedopportunitiestoworkinsmallgroupsor individually	0.07	0.66	0.44

However, accordingtothecomponentcorrelationmatrix, thefactorsweremoderatelycorrelated(0.55)indicatingthefactorsweresimilar.Therefore,aConfirmatoryFactorAnalysis(CFA) wasusedtodeterminewhetheralloftheitemscouldbeloadedintoasingledfactor.

Confirmatoryfactoranalysis

First,assumptionsweretestedandmultivariate44outlierswereremovedaswellas10incomplete responsesreducingthe*N*from332to278.ToconfirmwhetherECOwasunidimensional,student responseswereusedinaCFAtoexamineourhypothesizedmodelofonefactor.Accordingtothe itemcorrelationsdisplayedinTable6,thestrongestsinglefactorcorrelationwas $r = .71$,whichis belowtherecommendedcutofffordiscriminantvalidity,$r = .85$.

Next,thegoodnessoffittestwasexamined.TheComparativeFitIndex(CFI)scorewas0.94 andtheTucker-LewisIndex(TLI)scorewas0.92,bothofwhichmettheminimumcut-offscore of0.90,indicatinggoodinternalvalidity; $\chi^2(90) = 229.79$, $p < .001$. RootMeanSquareErrorof Approximation(RMSEA)andStandardizedRootMeanSquareResidual(SRMR)were0.75and 0.047respectively , bothofwhichindicateanacceptablemodelfit. Alltheestimatecoefficients loadingsweresignificantandwerepositiveforlatentvariablesandvariance(Table7).Although theresultswereclosetothecutoffscores,ECOcanbeconsideredaunidimensionalmeasureofa singlefactor—activelearning.

Table6. Itemcorrelations.

	q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	q12	q13	q14	q15
q1															
q2	.343**	–													
q3	.076	.293**	–												
q4	.260**	.208**	.120*	–											
q5	.277**	.490**	.402**	.279**	–										
q6	.247**	.453**	.379**	.217**	.682**	–									
q7	.252**	.355**	.330**	.261**	.649**	.666**	–								
q8	.152*	.418**	.359**	.340**	.493**	.544**	.516**	–							
q9	.165**	.432**	.299**	.160**	.541**	.714**	.624**	.505**	–						
q10	.222**	.394**	.332**	.127*	.433**	.483**	.499**	.403**	.525**	–					
q11	.190**	.437**	.339**	.216**	.572**	.627**	.653**	.542**	.607**	.492**	–				
q12	.275**	.457**	.372**	.178**	.604**	.664**	.605**	.538**	.623**	.521**	.621**	–			
q13	.151*	.414**	.512**	.163**	.582**	.611**	.568**	.478**	.530**	.478**	.557**	.625**	–		
q14	.206**	.484**	.307**	.227**	.574**	.569**	.462**	.408**	.574**	.357**	.517**	.521**	.510**	–	
q15	.202**	.509**	.392**	.158**	.547**	.569**	.535**	.490**	.586**	.409**	.567**	.623**	.617**	.619**	–

Note.SeeSupplementalAppendixforquestions.
**Correlation(*r*)issignificantatthe.01level(two-tailed).

PerceptionsofECO

Tenfacultymembersagreedtoprovidefeedbackon theECO.Overwhelmingly,therespondents indicatedthatECOwasusefulforavarietyofreasons.First,thereweresseveralmentionsregarding theaccuracy.Forexample,facultymadecommentssuchas,"Iwouldsayit'srightaboutontarget forhowtheyshouldrespond.""IthinkthedataaccuratelyrepresentswhatIobserve/doinclass." Itwasimportanttoestablishthatfacultyfelttheinstrumentanditsresultswereaccurate.

Comments were also made about the reporting formats. The first format is strictly numeric, showingmeansandpercentages,andtheotherprovidesgraphs.Overall,facultyclaimedthatusing bothreports"gavemeagoodpictureoftheirfeedback."Onefacultymemberresponded:

> "Theyarebothuseful.Icanextracttherawdatafromtheexcelsheetanduseitifneeded,andthesecond formatgiveavisualthatiseasytoflipthroughandseewhatareamightneedmorework."

Finally,allbutonefacultymemberstatedthattheywereabletousethedatatoimprovetheir teaching. The one faculty member who mentioned that they made no changes already had high scoresinactivelearning,whichservedtoconfirmthattheywerepromotingactivelearninginthe classroom.Fortheothers,commentswerepositiveandindicatedtheyfoundthedatahelpful,such as "I really appreciate the evaluation. It is helpful to have objective eyes making observations. ThereareThingsIcanlearnfromthedata.""Ididmakechangestobemoreinteractiveandbreak mylecturesupmore.Ifeltitwasverybeneficial."Overall,theresponsesindicatedthattheinstrumentwasaccurateanduseful.

Discussion

Theaimofthisstudywastoprovideinitialresultsfromtestinganewlydesignedteachingobservation protocol. ECO was designed to overcome common barriers to increased active learning in

Table 7. Latent variables and variance.

	Estimate	*SE*	*Z*	*p*	StdLv	StdAll
Latent variables						
q1	0.253	0.051	4.925	< .001	0.253	0.297
q2	0.356	0.034	10.475	< .001	0.356	0.586
q3	0.263	0.032	8.327	< .001	0.263	0.483
q4	0.266	0.057	4.675	< .001	0.266	0.283
q5	0.380	0.025	15.148	< .001	0.380	0.775
q6	0.303	0.018	16.879	< .001	0.303	0.833
q7	0.338	0.022	15.139	< .001	0.338	0.775
q8	0.321	0.026	12.176	< .001	0.321	0.661
q9	0.294	0.019	15.241	< .001	0.294	0.779
q10	0.297	0.027	11.065	< .001	0.297	0.613
q11	0.346	0.023	14.977	< .001	0.346	0.769
q12	0.343	0.022	15.875	< .001	0.343	0.801
q13	0.366	0.026	14.364	< .001	0.366	0.747
q14	0.302	0.023	12.881	< .001	0.302	0.690
q15	0.274	0.019	14.349	< .001	0.274	0.747
Variance						
.q1	0.659	0.056	11.718	< .001	0.659	0.912
.q2	0.242	0.021	11.400	< .001	0.242	0.656
.q3	0.228	0.020	11.564	< .001	0.228	0.767
.q4	0.814	0.069	11.725	< .001	0.814	0.920
.q5	0.096	0.009	10.665	< .001	0.096	0.399
.q6	0.040	0.004	10.094	< .001	0.040	0.306
.q7	0.076	0.007	10.667	< .001	0.076	0.399
.q8	0.132	0.012	11.212	< .001	0.132	0.563
.q9	0.056	0.005	10.641	< .001	0.056	0.394
.q10	0.147	0.013	11.342	< .001	0.147	0.624
.q11	0.082	0.008	10.708	< .001	0.082	0.408
.q12	0.066	0.006	10.458	< .001	0.066	0.359
.q13	0.106	0.010	10.848	< .001	0.106	0.442
.q14	0.100	0.009	11.113	< .001	0.100	0.524
.q15	0.059	0.005	10.851	< .001	0.059	0.442
f	1.000				1.00	1.00

Note. See Supplemental Appendix for list of questions.

higher education classrooms (Bonwell & Eison, 1991). Derived from existing teaching observation tools, especially the TDOP (Hora, 2015; Hora & Ferrare, 2014), the 15 questions of ECO, based on the best practices for engaged student learning, were designed to be easily deployed (e.g. through a Qualtrics survey), to assess higher-educational active learning in a succinct manner (e.g. student responses), and to be easily interpreted by faculty for formative review and instructional development. Positive results were found for ECO's internal consistency, interrater reliability, and one-dimensionality (unidimensional), supporting the validity and reliability of ECO. In addition, faculty whose classes completed the ECO tended to agree that the instrument accurately assessed what was done in the classroom and that the subsequent reporting of ECO results was easily interpretable and provided helpful, formative feedback for the faculty receiving them to improve active learning strategies in their classrooms.

ECO, an active learning assessment, was validated quantitatively with 500 student responses in 18 unique courses, and by the interrater reliability of trained coders, providing opportunity for timely student feedback and formative change for instructors. Faculty who use a simple, student report of active learning assessment, such as ECO, will be provided formative feedback allowing them to adapt classroom instruction in the same term that the feedback is given. This may help to address several barriers to increasing the prevalence of active learning in college classrooms and, given the available evidence, can be expected to promote student success (Betti et al., 2022; Miller et al., 2021).

In addition to providing faculty with a reliable measure of their own use of active learning in the classroom, ECO promises to aide faculty in other, complementary ways as well. For instance, it can help to inform faculty-student communication associating active learning classroom strategies with assessments of student learning. Recommendations are clear for instructors implementing active learning strategies in the college classroom: define for students what exactly is meant in the classroom regarding active learning and, if possible, tie the active learning strategy to learning outcomes (Hartikainen et al., 2019). Deslauriers et al. (2019) strongly recommended that instructors explain to students early in the semester that they will benefit from their engagement in classroom activities explicitly designed for student learning. Though some studies (Hao, 2016; Owens et al., 2017) reported varied reactions to active learning classrooms, helping students understand the value of active learning in the classroom is important. Deslauriers et al. (2019) also recommended instructors provide students with assessments designed to help students determine their learning, writing that, "The success of active learning will be greatly enhanced if students accept that it leads to deeper learning—and acknowledge that it may sometimes feel like exactly the opposite is true" (p. 19256). A validated instrument like ECO can be used by faculty to help students report their perceptions of active learning in the classroom. This is a valuable resource, as clear communication from instructors to students regarding the whys of active learning strategies in terms of learning outcomes benefits both students and instructors (Carless, 2022). ECO is a valid and reliable tool that can help with such clear communication between instructor and student.

In the current study, 10 faculty members provided feedback on the ECO instrument. This finding, though limited by the number of respondents, provides further support for the use of ECO in the college classroom. In particular, it suggests ECO is easy for faculty to use. Overall, faculty were positive about the instrument and found it helpful regarding the accuracy of the assessment of active learning in their classroom. Further, faculty found the reporting of the ECO results to be easily understood and highly applicable, helping them to pinpoint areas for improvement in their active learning strategies and subsequent student success. Thus, the utility of the ECO instrument results was strong in creating an effective feedback loop between activities designed by the instructor and student evaluation of such learning strategies (Carless, 2022).

Last, as employed in this study, ECO was delivered as a Qualtrics survey to students whose responses were used to help faculty identify employment of effective learning activities in their classrooms. However, it bears mention that ECO results may have a variety of further applications. For example, if deployed as a per-/post-test, it could provide assessment of university-wide pedagogical trainings (e.g. Teaching and Learning Center programing) and student support services. It may also serve administrators who develop appropriate incentive structures relative to faculty instruction and student learning. For example, ECO could be used as a measure of faculty performance in the classroom for the purpose of providing an objective measure of teacher effectiveness. It seems worth exploring these other applications.

This study is not without limitations. First, data to validate the ECO were drawn from students and faculty at one university in the southern United States. One statement calls for student assessment, "Professor appears to spend an appropriate amount of time in their instructional approaches (i.e. lectures, demonstration, group work, etc.)." The authors grant that this question calls for a student assessment that may differ based on the student's background, age, previous experience, and more. Thus, the question is open for use but must be considered by users of ECO. Also, one question primarily aimed to determine whether students were given time to practice, and combined group and individual opportunities. If the goal is to determine whether they are getting opportunities for both, one might consider separating these into two questions.

A second limitation is that student demographics are limited (see Table 1); future research on the validity and reliability of ECO and its usability by both students and faculty will need to be comprised of data from multiple universities in a variety of locations and include student demographics that influence student success in addition to race. For example, it is known that student gender (Bowman et al., 2022) influences student outcomes. In addition, first generation college students benefit from differing family supports and from providing an example for younger siblings (Cappanola & Johnson, 2022). Also, student religious affiliations, friends, and faculty, contribute to student academic success (Mishra, 2020). Each of these should be considered in future research and when possible, included as possible confounding demographics needing to be controlled. Further, there are limitations related to the levels of students providing feedback. Future research will want responses from freshmen, sophomore, juniors, and seniors, in addition to varied types of classes (e.g. STEM or social sciences or other types of courses).

Yet, as has been demonstrated (Theobald et al., 2020), active learning is known to "raise all boats" in the classroom; all students benefit with increased learning based on active learning teaching strategies designed by classroom instructors (Betti et al., 2022; Miller et al., 2021). This benefit has been shown to help all students, but especially those from underrepresented groups. ECO provides a simple tool for both students and instructors to know and understand the value of active learning in the classroom. This is to everyone's benefit. Students benefit from active learning in the classroom, and faculty benefit from timely feedback to inform their adaption of their active learning classroom strategies and assessments to further benefit student learning.

Data Availability

Anonymous data can be requested from the first author.

Declaration of conflicting interests

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Supplemental material

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References

Betti, A., Biderbost, P., & García Domonte, A. (2022). Can active learning techniques simultaneously develop students' hard and soft skills? Evidence from an international relations class. *PLoS One*, *17*(4), e0265408.

Birdwell, T., & Harris, T. (2022). Active learning classroom observation tool: Improving classroom teaching and supporting instructional change through reflection. *Journal of Learning Spaces*, *11*(1), 108–121.

Birdwell, T., Roman, T. A., Hammersmith, L., & Jerolimov, D. (2016). Active learning classroom observation tool: A practical tool for classroom observation and instructor reflection in active learning classrooms. *Journal on Centers for Teaching and Learning*, *8*, 28–50.

Bonwell, C. C., & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom*. George Washington University.

Bowman, N. A., Logel, C., LaCosse, J., Jarratt, L., Canning, E. A., Emerson, K. T. U., & Murphy, M.C. (2022). Gender representation and academic achievement among STEM-interested students in college STEM courses. *Journal of Research in Science Teaching*, *59*, 1876–1900. https://doi.org/10.1002/tea.21778

Cappanola, A. L., & Johnson, E. I. (2022). On being the first: The role of family in the experiences of first-generation college students. *Journal of Adolescent Research*, *37*(1), 29–58. https://doi.org/10.1177/0743558420979144

Carless, D. (2022). From teacher transmission of information to student feedback literacy: Activating the learner role in feedback processes. *Active Learning in Higher Education*, *23*(2), 143–153. https://doi.org/10.1177/1469787420945845

Deslauriers, L., McCarty, L. S., Miller, K., Callaghan, K., & Kestin, G. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academies of Sciences of the USA*, *116*(39), 19251–19257. https://doi.org/10.1073/pnas.1821936116

duRocher, A. R. (2020). Active learning strategies and academic self-efficacy relate to both attentional control and attitudes towards plagiarism. *Active Learning in Higher Education*, *21*(3), 203–216.

Eddy, S. L., Converse, M., & Wenderoth, M. P. (2015). Evidence-based teaching practices for active learning in large science, technology, engineering, and mathematics classes. *CBE-Life Sciences Education*, *14*, 1–16.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academies of Sciences of the USA*, *111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Hao, Y. (2016). Exploring undergraduates' perspectives and flipped learning readiness in their flipped classrooms. *Computers in Human Behavior*, *59*(1), 82–92. https://doi.org/10.1016/j.chb.2016.01.032

Hartikainen, S., Rintala, H., Pyvläs, L., & Nokelainen, P. (2019). The concept of active learning and the measurement of learning outcomes: A review of research in engineering higher education. *Education Sciences*, *9*(4), 276. https://doi.org/10.3390/educsci9040276

Hora, M. (2015). Toward a descriptive science of teaching: How the TDOP illuminates the multidimensional nature of active learning in postsecondary classrooms. *Science Education*, *99*(5), 783–818.

Hora, M., & Ferrare, J. (2014). *The teaching dimensions observation protocol (TDOP) 2.0*. University of Wisconsin-Madison, Wisconsin Center for Education Research.

McCarthy, J. P., & Anderson, L. (2000). Active learning techniques versus traditional teaching styles: Two experiments from history and political science. *Innovative Higher Education*, *24*(4), 279–294.

Miller, D., Deshler, J., McEldowney, T., Steward, J., Fuller, E., Pascal, M., & Michaluk, L. (2021). Supporting student success and persistence in STEM with active learning approaches in emerging scholars classrooms. *Frontiers in Education*, *6*, 667918. https://doi.org/10.3389/feduc.2021.667918

Mishra, S. (2020). Social networks, social capital, social support and academic success in higher education: A systematic review with a special focus on 'underrepresented' students. *Educational Research Review*, *29*, 100307. https://doi.org/10.1016/j.edurev.2019.100307

Narayan, R., Rodriguez, C., Araujo, J., Shaqlaih, A., & Moss, G. (2013). Constructivism—constructivist learning theory. In B. Irby, G. H. Brown, R. Lara-Aiecio, & S. A. Jackson (Eds.), *The Handbook of educational theories* (pp. 169–183). Information Age Publishing.

Owens, D. C., Sadler, T. D., Barlow, A. T., & Smith-Walters. (2017). Student motivation from and resistance to active learning rooted in essential science practices. *Research in Science Education*, *50*, 253–277. https://doi.org/10.1007/s11165-017-9688-1

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher*, *24*(7), 5-–12.

Prince,M.(2004).Doesactivelearningwork?Areviewoftheresearch.*JournalofEngineeringEducation*, *93*(3),223–231.
Rincon-Flores, E. G., & Santos-Guevara, B. N. (2021). Gamification during COVID-19: Promoting active learning and motivation in higher education. *Australasian Journal of Edicational Technology*, *37*(5), 43–60.
Rossi.,I.V.,DinorádeLima,J.,Bruna,S.,Nunes,M.A.F.,Ramirez,G.E.,&Ramirez,M.I.(2021).Active learningtoolsimprovethelearningoutcomes,scientificattitude,ancriticalthinkinginhighereducation: ExperiencesinanonlinecourseduringtheCOVID-19pandemic. *BiochemistryandMolecularBiology Education*,*49*,888–903.
Stains, M., Harshman, J., Barker, M. K., Chasteen, S. V., Cole, R., DeChenne-Peters, S. E., Eagan, M. K. Jr., Esson, J. M., Knight, J. K., Laski, F. A., Levis-Fitzgerald, M., Lee, C. J., Lo, S. M., McDonnell, L. M., McKay, T. A., Michelotti, N., Musgrove, A., Palmer, M. S., Plank, K. M., . . . Young, A. M. (2018). AnatomyofSTEMteachinginNorthAmericanuniversities. *Science*, *359*,1468–1470.https:// doi:10.1126/science.aap8892
TeachingDimensionsObservationProtocol. TeachingDimensionsObservationProtocol(TDOP)2.1users guide.http://tdop.wceruw.org/Document/TDOP-2.1-Users-Guide.pdf.
Theobald,E.J.,Hill,M.J.,Agrawal,S.,Arroyo,E.N.,Behling,S.,Chambwe,N.,Cintrón,D.L.,Cooper,J. D.,Dunster,G.,Grummer,J.A.,Hennessey,K.,Hsiao,J.,Iranon,N.,Jones,L.,II.,Jordt,H.,Keller,M., Lacey,M.E.,Littlefield,C.E.,Lowe,A.,Newman,S.,. . .Freeman,S.(2020).Activelearningnarrows achievementgapsforunderrepresentedstudentsinundergraduatescience,technology,engineering,and math. *Proceedingsofthe NationalAcademiesofSciencesoftheUSA*, *117*(12),6476–6483.https://doi. org/10.1073/pnas.19169031
Waitkus, J. (2006). Active learning in humanities courses: Helping students to think critically. *Journal of CollegeTeaching&Learning*,*3*(1),57–62.
Board of Regents of the University of Wisconsin System. (2010) Welcome to TDOP. http://tdop.wceruw. org/(accessed31May2022).

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