A Tale of Two Quests: The (Almost) Non-Overlapping Research Literatures on Students' Evaluations of Secondary-School and University Teachers

Herbert W. Marsh, Australian Catholic University and Oxford University, UK

Theresa Dicke, Australian Catholic University

Mathew Pfeiffer, Australian Catholic University

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Herbert W. Marsh, Australian Catholic University and Oxford University.
Herb.Marsh@acu.edu.au
Institute for Positive Psychology and Education (IPPE)
Australian Catholic University, North Sydney, NSW 2060

Theresa Dicke, Australian Catholic University
Theresa.Dicke@acu.edu.au
Institute for Positive Psychology and Education (IPPE)
Australian Catholic University, North Sydney, NSW 2060

Mathew Pfeiffer, Australian Catholic University .
mathew.pfeiffer2@myacu.edu.au
Institute for Positive Psychology and Education (IPPE)
Australian Catholic University, North Sydney, NSW 2060

Herbert W. Marsh, Corresponding Author
Herbert W. Marsh, Australian Catholic University and Oxford University.
Herb.Marsh@acu.edu.au
Institute for Positive Psychology and Education (IPPE)
Australian Catholic University, North Sydney, NSW 2060

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Abstract

Many 1000s of studies have been conducted on the validity and diagnostic usefulness of students' evaluations of university teaching (SET), but there is a surprising lack of research on ratings by secondary students. Integrating these two disparate research areas, we evaluate the appropriateness of university SET instruments to secondary settings. Secondary students evaluated an effective and less effective teacher using items adapted from two university instruments, supplemented by items for secondary settings, and rated the appropriateness and importance of each item (N = 761 sets of ratings of more than 400 teachers, Years 7-11, 10 schools). All items were seen as appropriate and important. Factor analyses of responses to both instruments supported their a priori factor structure, and multitrait-multimethod analyses supported their convergent and discriminant validity. We discuss directions for further research at the secondary level based on the extensive body of research on the reliability, validity, and usefulness of SETs at the university level.

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Highlights:

Students' evaluations of teaching widely studied in universities but not schools

Need to integrate research on student ratings of university and school teachers

University teacher rating instruments demonstrated applicable in school settings

Secondary students discriminate evaluation factors similar to university students

Good psychometric support for 15-factor teacher evaluation instrument

Keywords: Students' evaluations of Teaching; teaching effectiveness; educational measurement; Exploratory structural equation modeling;

A Tale of Two (Almost) Non-Overlapping Research Areas:

Student's Evaluations of High School and University Teachers

'The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The great teacher inspires." William Arthur Ward

Most people remember their teachers. Nearly everybody is able to tell you a funny story about a really bad teacher and their quirks, but also about an inspiring teacher who has helped shape their life (a "great" teacher according with William Arthur Ward). And indeed, research shows that teachers matter and are crucial for the learning process (Hattie, 2002; OECD, 2005; Stecher et al., 2018). But what is a great teacher? What defines a great teacher? And how could we measure if somebody is a great teacher? How can we provide feedback and assistance to make teachers more effective? By addressing these questions, our research will inform processes to improve the effectiveness of secondary school teachers and their schools to serve the community, build human capital, and also enrich and advance the international research agenda in relation to the theory, research and practice in teacher education and educational psychology.

Indeed, particularly at the state and national level in the U.S., but also in countries all over the world, there is increased emphasis on the evaluation of effectiveness of secondary schools, teachers, and classes (Stecher et al., 2018). As part of this shift there is renewed interest, but only a limited amount of research into, the use of students' evaluations of teaching at the secondary level (S-SETs). Furthermore, even this limited amount of research into S-SETs has not resulted in psychometrically strong, robust instruments with well-differentiated factor structures (e.g. Kuhfeld, 2017; Schweig, 2014; Wallace, Kelcey & Ruzek, 2016). Thus, Kuhfeld (2017; (Bill & Melinda Gates Foundation, 2012) reported that in the US student perceptions of teaching are currently mandated in seven states while 26 other states allow their use in teacher evaluations.

In contrast to secondary school settings, students' evaluations of teaching in universities (U-SETs) are widely used to evaluate teaching effectiveness and to provide diagnostic feedback to improve teaching across the world. U-SETs have been the basis of literally 1000s of published

articles into the dimensionality, reliability, validity, and usefulness for diverse purposes. In their review of U-SET research Author (1986) noted that the primary use of U-SETs SETs is to provide diagnostic feedback to faculty for improving teaching, but also a measure of teaching effectiveness for personnel decisions; one component in national and international quality assurance exercises, designed to monitor the quality of teaching and learning; an outcome or a process description for research on teaching, and, perhaps, information for students for the selection of courses and instructors. Particularly the first purpose, but perhaps the others as well are relevant for consideration in a secondary school setting. Furthermore, the perspectives provided by higher-education research is relevant in that it offers alternative perspectives that should be useful to school-effectiveness research, but also because it seems that some of the strategies used in this higher-education research could easily be adapted to school effectiveness research (e.g., Bill & Melinda Gates Foundation, 2010; Stecher et al., 2018). Nevertheless, based on the RAND Corporation (Stecher et al., 2018) study of the most extensive research program to evaluate and improve school teaching effectiveness, the Washington Post (29 June, 2018) reported: "Bill Gates spent hundreds of millions of dollars to improve teaching. New report says it was a bust."

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Remarkably, there has been a surprising lack of synergy across the S-SET and U-SET research literature, particularly in relation to the measures used. This is surprising in that the U-SET literature has a number of well-developed instruments that have been shown to be psychometrically strong in terms of factor structure, validity, and usefulness, whereas this appears not to be the case in the S-SET literature. This led us to focus this article as a tale of two (almost) non-overlapping research literatures and to begin to process of integrating the two. More specifically, the purpose of the present investigation is to evaluate whether U-SET instruments –supplemented with items potentially more appropriate to secondary settings--are applicable to secondary school settings. In order to address this issue, we review of relevant U-SET research and its relevance to S-SET research, then apply lessons from the extensive U-SET research literature to evaluate the

applicability of psychometrically strong U-SET instruments to secondary school settings, and finally develop a new instrument specifically designed for S-SETs.

SETs in University Settings (U-SETs)

Here we provide a brief overview of the huge body of work into U-SETs (also see Supplemental Materials, Section 1 [SM:S1] for further discussion). In their systematic review of the history of U-SETs, Spooren, Vandermoere, Vanderstraeten, and Pepermans (2017) emphasized that U-SETs are now used in "almost every institution of higher education throughout the world" (p. 130); they are the basis of literally many thousands of peer-reviewed journal articles covering in detail topics such as their usefulness, validity, and dimensionality, making it one of the most widely studied topics in education and educational psychology journals. This research shows that U-SET ratings, when based on appropriate instruments, are reliable, valid (in relation to student learning, teacher self-evaluations, ratings by former students), relatively unbiased by potential source of bias (e.g., workload/difficulty, gender, expected grades, class size) and useful in providing diagnostic strengths and weaknesses that can lead to improved teaching effectiveness when coupled with a consultative feedback intervention (Author, 1987; 2007; Author & Dunkin, 1992; also see Benton & Cashin, 2014; Cashin, 1988; Benton & Ryalls, 2016; Spooren et al., 2017; Wachtel, 1998). In some of the most comprehensive reviews of this research, Author (1987; 2007; Author & Dunkin, 1992) concluded that U-SETs are one of the most highly researched personnel evaluation systems, and one of the best in terms of validity, reliability, and usefulness. However, there is also a number of studies critical of U-SETs and their universal use in universities across the world continues to be controversial (see review by Spooren, Brockx & Mortelmans, 2013). Nevertheless, this well-developed field of U-SET research—the methodology, substantive findings, purposes and even the controversies--provides a strong basis evaluating the generalizability of the U-SET instruments and research to secondary school settings where there is relatively little research (see subsequent discussion of S-SET research).

Dimensionality: Student Evaluation of Educational Quality (SEEQ) Instrument.

Researchers and practitioners (e.g., Abrami & d'Apollonia, 1990; Benton & Cashin, 2014; Cashin, 1988; Feldman, 1997; Author, 2007~~b~~; Author & Roche, 1993; Renaud & Murray, 2005; Richardson, 2005) agree that teaching is a complex, multidimensional activity comprising multiple interrelated components (e.g., clarity, interaction, organization, enthusiasm, feedback). Hence, U-

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SETs, like the teaching they are intended to represent, should also be multidimensional. From this perspective, a critical starting point for U-SET research was factor analysis studies demonstrating that U-SETs instruments had a well-defined, multidimensional factor structure in support of a priori factors that the U-SET instrument was designed to measure. Similarly, this should be the starting point for S-SET research. Particularly strong support for the multidimensionality of U-SETs comes from SEEQ research (Author, 1982, b; 1987; 2007b; Author & Dunkin, 1997; Author & Hocevar, 1991; Richardson, 2005; see SM:S1 for further discussion). In evolving best practice of factor analysis methodology, Author, Morin, Parker, and Kaur (2014) demonstrated the application of exploratory structural equation modeling (ESEM) based on a large normative archive of SEEQ ratings, performing better than conventional confirmatory factor analysis (CFA).

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Although there are many U-SET instruments, the Student Evaluation of Educational Quality (SEEQ) instrument, that is the basis of the present investigation, is broadly acknowledged to be the most widely studied instruments in the world. Thus, an overarching review of student rating instruments used to collect feedback about effectiveness in higher education, Richardson (2005, p. 404) concluded:

> *It is clearly necessary that such a questionnaire should be motivated by research evidence about teaching, learning and assessment in higher education and that it should be assessed as a research tool. The only existing instruments that satisfy these requirements are the SEEQ [Student Evaluation of Educational Quality; Author, 1984, 1987] (for evaluating individual teachers and course units).*

Similarly, in their integrative review of U-SET research, Wright and Jenkins-Guarnieri (2012) concluded that: One SET measure in particular has benefited from ample, sound research and appears to be a reliable and valid, multidimensional measure of teaching effectiveness: the Students' Evaluation of Educational Quality (SEEQ; Author 1982). More generally, Boysen (2016) argues effective use of U-SETs requires the use of standardized, multidimensional instruments the established reliability and validity such as SEEQ and a relatively few other U-SET instruments that have a strong research basis,

Focus on Improving Teaching Effectiveness.

The focus of U-SET research on factor structure is important from a psychometric perspective, but Author (2007; Author & Roche, 1994) argued that the identification of distinguishable factors is critical in terms of providing diagnostic feedback that is useful for improving teaching effectiveness that has been an

important emphasis in U-SET research. Indeed, receiving feedback from U-SETs is nearly universal in universities world-wide and largely viewed positively by university teachers as having a positive impact on improving teaching effectiveness (Boysen, 2016; Flodén, 2017; Mart, 2017; Spooren, Brockx & Mortelmans, 2013).

Although relative usefulness of a single global score compared to a multidimensional profile of specific components and overall rating items for use in personnel decisions is the source of much debate in higher education research (e.g., Abrami & d'Appollona, 1990; Boysen, 2016; Author, 1987; 2007), there is broad agreement that the multidimensional perspective is more useful for purposes of feedback aimed at improving teacher effectiveness and research on teaching. In support of this rationale, Author (2007; Author & Roche, 1993) developed and tested a prototype feedback/consultation based on the SEEQ instrument. In addition to random assignment, key features of this intervention research involved teachers evaluating themselves and being evaluated by their students in two different classes taught in consecutive semesters. Feedback teachers selected one or two target SEEQ factors (e.g., Learning/value, Enthusiasm, Organisation, Breadth of Coverage, Group Interaction) that were the focus of their intervention. Teachers typically selected SEEQ factors for which they were relatively weak (based on prior U-SETs and their own teacher self-evaluations), but that were seen as important to improve by the teacher. The SEEQ feedback/consultation provided an effective means of improving university teaching. Feedback Teachers were rated .5 SD higher than randomly assigned control teachers on overall rating items. Importantly, the differences were much larger for targeted SEEQ factors (chosen by teacher as the focus of their intervention) and much smaller for non-target SEEQ factors. These factors targeted by each teacher went from being weakest SEEQ factors (which was why they were chosen) to being among the strongest as a consequence of the intervention. These results support the construct validity of the intervention and the multidimensional perspective upon which it was based. However, the results also demonstrate that the SEEQ factors are not only distinguishable in actual settings, but are also amenable to systematic change based on intervention. We argue that this focus on a well-defined factor structure that has been so important in SEEQ research and U-SET research more generally should also be a critical starting point for S-SET research as well.

Juxtaposition of U-SET and S-SETs Research

There is great interest and an increasing call by the public and policy makers alike for use of measures and systems for evaluating educational, school, and teacher effectiveness (Garret & Steinberg,

2015; Van der Lans, van de Grift & van Veen, 2015; Author, Nagengast, Fletcher, & Televantou, 2011; Stecher et al., 2018; Steinberg & Donaldson, 2016). This is a natural extension of increasing emphases on parental choice, better feedback, improved education, greater accountability, freedom of information, and international comparisons and country rankings based on large-scale national and international assessments like the Programme for International Student Assessment (PISA) and Third International Mathematics and Science Study (TIMSS). Many of these systems have focussed on so called value-added models, which aim to identify the extent to which a school or an individual teacher has contributed to students' achievement gains over the school year, while controlling for student background characteristics and prior achievement (e.g., Hanushek & Rivkin, 2010; Author et al. 2011). These value-added models, however, are often times critiqued for the assumption that student learning is (a) perfectly assessed by a given test and (b) solely influenced by the teacher, thereby not taking into account any context factors such as school resources, other teachers, individual student needs etc. (for an overview see Darling-Hammond, 2015; also see OECD working paper by Isoré, 2009) and have been deemed as not sufficiently valid as a measure of teachers' actual effectiveness (Darling-Hammond, 2013; Van der Lans et al., 2015; also see Stecher et al., 2018).

A frequent additional component of these evaluation systems based on achievement test scores are classroom observations by external observers (e.g., using standardized observing tools) and teachers (Praetorius, Lenske & Helmke, 2012). Although these external observations can be reliable under appropriate circumstances, this is highly dependent on sampling procedures, instruments, the training of raters and the number of raters; they are also very expensive and labour-intense (Goe, Bell & Little, 2008; Lüdtke, Robitzsch, Trautwein, & Kunter, 2009; Author et al., 2011). Thus, for example, Kane and Staiger (2012) reported that even with highly trained raters who rated classroom observation videos, the reliability of single observation ratings ranged from .14 to .34. In his review of U-SET research, Author (2007) reported peer evaluations based on classroom observations by colleagues and administrators were highly unreliable (i.e., ratings by different peers do not even agree with each other) and relatively unrelated to any other indicator of effective teaching (Centra, 1979). However, Murray (1983) argued that highly trained external observers are able to reliably evaluate specific teaching behaviors. However, even here the median single-rater agreement among different observers of the same teacher was only .32—similar or better than that found in secondary research summarized by Kane and Staiger (2012). Hence, in order to achieve a reasonable level of reliability of only .77 for the mean rating across multiple observers, 18-24 sets of ratings

were needed. Author (2007) argued that this should not be surprising in that class-average U-SETs needed at least 10 students per class to achieve a reliability of .74 (or .90 based on 25 students per class)—even though students have much greater exposure to a teacher than do external observers.

Given these difficulties with different measures used to assess teaching effectiveness at the secondary level, it is not surprising that in their overview of different measures of teaching effectiveness, Goe et al., (2008, p. 52) recommended that policy makers and researchers:

> *Resist pressures to reduce the definition of teacher effectiveness to a single score obtained with an observation instrument or through a value-added model. There is no single measure that captures everything that a teacher contributes to educational, social, and behavioral growth of students, not to mentions ways teachers impact classrooms, colleagues, schools and communities.*

Although U-SETs have been used extensively to evaluate university teaching effectiveness at most universities in much of world, until recently S-SETs have rarely been used systematically as a tool for evaluating and improving the effectiveness of secondary school teachers (Fauth, Decristan, Rieser, Klieme, & Büttner, 2014; Kuhfeld, 2017). Thus, the OECD working paper on teacher evaluation (Isoré, 2009) reports that student surveys are rarely used for either summative or formative evaluation in OECD countries. Furthermore, a major focus of university SET research has been to provide teachers with diagnostic feedback in relation to specific components of teaching effectiveness that leads to improved teaching as well as for personnel decisions and research on teaching more generally. In contrast, S-SETs have not been widely studied, particularly not as a formative feedback tool that leads to improved teaching effectiveness (Gaertner, 2014). There is however, some S-SET research (e.g., Lüdtke et al., 2009; Wagner, Göllner, Helmke, Trautwein, & Lüdtke, 2013; Wagner et al., 2016) showing that students can distinguish different components of teaching effectiveness such as student-oriented climate, efficient classroom management, and cognitively challenging learning opportunities (Baumert et al., 2010; Baumert,, Lehmann, et al., 1997; Klieme, Lipowsky, Rakoczy, & Ratzka, 2006; OECD, 2013; Pianta & Hamre, 2009; Pianta, La Paro & Hamre 2008; Schiefele & Schaffner, 2015)—components of teaching effectiveness that we consider further in the present investigation (see SM:S1 for further discussion). In a feasibility study based on SEEQ items conducted in the UK secondary school settings, it was concluded (Kime, p. 209): "There was strong support from the participating teachers for the mission of using SETs to improve teaching" and "Focus group 'talk aloud' exercises conducted with students revealed a sound understanding of the meanings of items used in the

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instrument." This previous research and the UK feasibility study demonstrate that secondary students have the ability to make these sorts of ratings. Nevertheless, this research has been primarily aimed at research on teaching rather than as a measure of effective teaching or feedback to teachers intended to lead to improved teaching effectiveness.

Indeed, this perspective has been embraced as part of the large-scale Measures of Effective Teaching (MET) research project (Bill & Melinda Gates Foundation, 2010; Ferguson, 2010; also see Stecher et al., 2018) in which one aim was to build a fair and reliable system using student ratings to help teachers improve and administrators to make better personnel decisions. Particularly relevant to the present investigation, the Tripod instrument developed as part of the MET was designed to measure seven components (the seven Cs: Care, Control, Clarify, Challenge, Captivate, Confer, and Consolidate) that could be distinguished by students and provide diagnostic feedback to teachers. Indeed, the intended purposes of these S-SETs based on TRIPOD ratings by secondary students are similar to those of U-SETs at the university level. In particular, in a review of the Tripod instrument, Kuhfeld (2017, p. 254) emphasized that the "main advantages cited by survey proponents are that survey results point to strengths and areas for improvement, the items have face validity and reflect what teachers value, and survey results demonstrate relatively high consistency (Bill & Melinda Gates Foundation, 2012)." However, in systematic analyses of the factor structure underlying Ferguson's (2010) 36-item Tripod instrument used in the MET research provided no support for the a priori factor structure (the seven Cs) nor for the ability of Tripod responses to differentiate between specific components of teaching effectiveness or to meet minimal standards of a well-defined factor structure (Wallace, Kelcey & Ruzek, 2016; Kuhfeld, 2017; see SM:S1 for further discussion).

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In summary, there is not much systematic research and little support for the assumption by Ferguson's (2010) and others (see reviews by Kuhfeld, 2017, and Wallace, et al., 2016) that S-SETs at the secondary school level are able to identify a well-defined, multidimensional profile of distinguishable components of teaching effectiveness. Nevertheless, the assumption is important and underpins much of the potential usefulness of S-SETs to improve teaching effectiveness. Furthermore, in contrast to the limited body of S-SET research, the assumption has received considerable support from a very large body of U-SET research. Given this apparently extreme difference in results based on two largely non-overlapping research literatures, the overarching purpose of the present investigation is to evaluate the applicability of U-SET instruments in secondary schools.

Evaluating the Appropriateness of U-SET Instruments in Secondary School Settings.

How can we begin to evaluate the appropriateness of U-SET instruments to secondary school settings? In a related concern, it was noted that early U-SET research and instruments were largely based on North American studies. Author (1981; 1984; 2007) argued that it should not automatically be assumed that these instruments developed for use in North American universities were equally appropriate for use in different countries around the world and other tertiary settings. Thus, he developed what became known as the "applicability paradigm" to evaluate this assumption based on what were chosen to be the psychometrically strongest U-SET instruments: the SEEQ instrument (Author, 1987, 2007; Author et al., 2011) already discussed and the Endeavor (Frey, 1973, 1978; Frey, Leonard, & Beatty, 1975) instrument. [For a more detailed discussion of design and results based on this paradigm, see SM:S2]. In particular, both the SEEQ and Endeavor instruments had well-defined multidimensional factor structures. In a series of four articles implementing the this approach at diverse tertiary settings (see review by Author, 1986), university students were asked to select a more effective and less effective instructor from their previous experience and to evaluate these instructors on a survey that included all the items from both the SEEQ and Endeavor instruments. In a systematic review of the four studies, Author (1986) reported that (a) all items were judged to be appropriate by a large majority of the students; (b) all items were selected by some students as being most important; (c) there was a surprising consistency in the items judged to be less appropriate and most important across settings; (d) all but the Workload/Difficulty items clearly differentiated between good and poor instructors; (e) factor analyses generally replicated the factors that the SEEQ and Endeavor instruments were designed to measure; and (f) multitrait-multimethod (MTMM) analyses demonstrated strong support for both the convergent and divergent validity of SEEQ and Endeavor responses. Although this approach has been successfully applied in test the appropriateness of U-SET instruments to different tertiary settings, it apparently has never been previously used in secondary school settings. Nevertheless, the extension of this paradigm seems ideally suited to evaluating the appropriateness of U-SET instruments to secondary school settings – the focus of the present investigation.

The Present Investigation and Research Hypotheses.

At the secondary school level there is limited research and little evidence that S-SETs are able to identify a well-defined, multidimensional profile of distinguishable components of teaching effectiveness that provide feedback to teachers that is useful for improving teaching effectiveness. In marked contrast, at

the university level there is a huge literature in support of this assumption. However, there is almost no overlap and a remarkable lack of synergy between studies done in secondary school and university levels. Hence, the overarching purpose of the present investigation is to address this remarkable failure to integrate what should be closely related concerns in these two (almost) non-overlapping research literatures and to evaluate the appropriateness of U-SET instruments in secondary schools.

Construction an item pool extending the SEEQ and Endeavor instruments:

For present purposes we constructed on item pool (Appendix 1) based on the SEEQ and Endeavor items, supplemented by instruments in used in secondary schools and interviews with secondary school principals and school personnel (who were part of the study) about components of teaching effectiveness that might be unique to secondary school settings. These include classroom management, use of ICT in the classroom, and three scales related to Self Determination Theory: cognitive activation, teacher support of student choice, and teacher support of appropriate relevance; see further discussion in the Methods section and in SM:S2) that are posited to be distinct from factors measured by SEEQ and Endeavor. Secondary students in Grades 7-11 from 10 schools evaluated an "effective" and a "less effective" teacher, indicated "inappropriate" items and selected items that were "most important" in describing either positive or negative aspects of the overall learning experience. For this preliminary analysis, we hypothesize that:

- SEEQ and Endeavor items will differentiate between effective and less effective teachers (Hypothesis 1A), be seen by secondary-school students as appropriate (Hypothesis 1B), and be seen as important by secondary-school students (Hypothesis 1C).

We leave as research questions how these S-SET results compare with those based on previous U-SET (e.g., Author, 1986), and how results based on the SEEQ and Endeavor factors compare with items designed to measure additional factors.

Factor analysis

We begin with a factor analysis of the S-SET items from the SEEQ and Endeavor instruments. However, noting previous concerns with the potential inappropriateness of traditional confirmatory and exploratory factor analysis (EFA and CFA), we apply newly evolving exploratory structural equation factor analysis (ESEM) claimed to represent an ideal compromise between the rigor of CFA and the flexibility of EFA. We hypothesize that:

- ESEM will identify a well-defined factor structure identifying each of the 16 (9 SEEQ and 7 Endeavor) factors that meets current criteria of goodness of fit (Hypothesis 2a), but that the CFA will provide a poorer fit and less well-differentiated factors than the ESEM (Hypothesis 2B).

We leave as a research question as to whether CFA goodness of fit is acceptable.

MTMM analysis.

MTMM analyses are the most widely used strategy for evaluating the construct (convergent and divergent) validity of multidimensional constructs. Although SEEQ and Endeavor instruments were independently designed and do not even measure the same number of components of effective teaching, a content analysis of the items and factors (Author, 1981, 1986) suggested that there was considerable overlap. There appears to be a one-to-one correspondence between the first five SEEQ factors (Group Interaction; Learning/Value; Workload/Difficulty; Exams/Grading; Individual Rapport) and the five Endeavor factors (Class Discussion, Student Accomplishments; Workload; Grading/Exams; Personal Attention) whereas the Organization/Clarity factor from SEEQ seems to combine particularly the Presentation Clarity but also the Planning factors from Endeavor. The remaining three SEEQ factors—Instructor Enthusiasm, Breadth of Coverage, and Assignments/Readings—do not appear to parallel any factors from Endeavor. Also, the SEEQ instrument has two overall rating items (Overall Class, most related to the Learning/Value factor and Overall Teacher, most related to the Instructor Enthusiasm factor), whereas the Endeavor instrument has none. Based on this content analysis and the widely used the Campbell and Fiske (1959) guidelines for the evaluation of MTMM matrices, we hypothesize that:

- In support of convergent validity (Hypothesis 3A), correlations among the matching SEEQ and Endeavor factors (convergent validities) will be statistically significant and substantial.
- In support of discriminant validity (Hypothesis 3B), these convergent validities will be larger than correlations between non-matching SEEQ and Endeavor factors, correlations among SEEQ factors and correlations among Endeavor factors

Item Selection and evaluation of the final SEEQ-S instrument.

In this phase we consider the entire pool of 104 items (see Appendix 1) designed to measure the 10 factors from the SEEQ and Endeavor instruments and five additional factors relevant for the secondary school environment, namely classroom management, usage of technology, and Self Determination Theory based scales relating to teachers supporting student autonomy (Cognitive Activation, teacher support of

student choice, and teacher support of appropriate relevance; see Supplemental Material Section 1 for details). Adapting methodology used to develop short-forms from well-established long forms (Author, Martin & Jackson, 2010; Author, Ellis, Parada, Richards & Heubeck, 2005; Smith, McCarthy & Anderson, 2000) we then selected a total of 51 "best" items to represent each of 15 different factors (see Methods section for further discussion). Because we are interested in the generalizability of this final secondary SEEQ (SEEQ-S) instrument over different age groups, we then used multigroup models to test invariance of the factor structure over lower secondary (Years 7 and 8) and upper secondary (Grades 9, 10 and 11) classes. Based on this selection process resulting in 51 items to represent 15 factors, we hypothesize that:

- ESEM will result in a well-defined factor structure identifying each of the 15 factors (H4a).
- The ESEM factor structure will demonstrate full (configural, metric, scalar) invariance over lower secondary (Years 7 and 8) and upper secondary (Grades 9, 10 and 11) students.

Methods

Participants and Data Collection Procedure.

Participants were secondary school students (N = 761 sets of ratings by 389 students in grades 7-11, aged 11-17 years, 54% female) from ten non-selective, independent high schools (two single-sex male, two single-sex female, and six co-educational) located in four Australian states. Because of the anonymity of the data collection in terms of students and the teachers they evaluated, we were not able to precisely estimate the total number of teachers that were evaluated in the 761 sets of ratings. To the extent that each student chose different teachers the number would be 761 teachers, but we conservatively estimate that a total of at least 400 teachers were evaluated across the 10 schools, five year groups, and the two teachers evaluated by each student. School principals from 14 schools were individually briefed on the nature of the study and ensured that all student data and the teacher identification would remain anonymous; 10 schools agreed to participate. Principals were asked to randomly select 10 students from each of the five year groups, grades 7 to 11. Informed consent and parental/guardian permission to participate was sought in accordance with internal school policies and university ethics procedures.

All questionnaires were completed via individual laptops/iPads during Term 4 of 2017. Each student completed two identical online questionnaires using the Qualtrics platform, taking place on school grounds during regular school hours. The order of item presentation was randomized separately for each student. Each testing session commenced with a brief set of instructions on how to access and complete the questionnaire.

One set of instructions asked students to complete the questionnaire in relation to an 'effective teacher' and the other a 'less effective teacher' (half the students rated the effective teacher first). These instructions were communicated through student emails containing the questionnaire link, or alternatively via an identical script which was read verbatim by teachers, who further provided a URL address code to access the online questionnaire. The latter procedure was requested by some schools in order to streamline the administration process, which took approximately 20-25 minutes duration. Students were asked to complete the questionnaire on their own and to not discuss their responses.

Materials (see Appendix 1 and Supplemental Materials)

The item pool of 104 items (see Appendix 1) was developed with the Qualtrics electronic survey development tool, using a 9-point (agree-disagree) Likert response scale. In the first phase of this project, based on feedback from secondary school principals and practitioners, we refined SEEQ and Endeavor items to be more appropriate to the school context. As part of this process we also adapted scales that are seen to be relevant to the secondary school environment: classroom management (Baumert et al., 2010; Baumert et al., 1997), the increasing role of technology in learning (e.g., teacher's usage of ICT in the classroom Koh, Chai, & Tay, 2014; Koh & Chai, 2016), and scales derived from Self Determination Theory (Deci & Ryan, 2010; Ryan & Deci, 2017; Ryan & Deci, 2009; Vansteenkiste et al., 2012; Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009) relating to teachers supporting student autonomy: cognitive activation (Baumert et al., 2010; OECD, 2013; Pekrun, Goetz & Frenzel, 2005); teacher support of student choice (Choice; Belmont, Skinner, Wellborn & Connell, 1988), and teacher support of appropriate relevance (Relevance; Belmont, et al., 1988). The rationale for inclusion of these additional five factors is described in more detail in SM:S3. From the perspective of SDT, an autonomy supportive teacher promoted student choice, volitional functioning, and a sense of initiative, interest and relevance (Assor, Kaplan & Roth, 2002; Sosic-Vasic, Keis, Lau, Spitzer, & Streb, 2015). Thus, we tested the applicability of 10 factors based on the SEEQ and Endeavor instruments, but also the appropriateness of five additional factors that were not included in the SEEQ and Endeavor instruments. Secondary students in Grades 7-11 from 10 schools evaluated an effective and a less effective teacher, indicated "inappropriate" items and selected items that were most important in describing either positive or negative aspects of the overall learning experience. (See SM:S4 for more detail on the sample, materials, and procedures)

Statistical Analyses

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Statistical analyses were done with Mplus 8 (Muthén & Muthén, 1998-2017) using robust maximum likelihood estimator (MLR), which is robust against violations of normality assumptions. Consistent with the logic of the applicability paradigm, the data collection process meant that a large number of different teachers were evaluated and that ratio of classes to students was very large (i.e., it was unlikely that different students would be evaluating the same class). However, as each student evaluated two classes, we treated student as the cluster and used the Mplus complex design option to appropriately adjust standard errors. Because of the nature of the data, there were almost no missing data. Nevertheless, to make full use of the data, we applied the full information maximum likelihood method (FIML; Enders, 2010).

Goodness of Fit. Generally, given the known sensitivity of the chi-square test to sample size, to minor deviations from multivariate normality, and minor misspecifications, applied SEM research focuses on indices that are relatively sample-size independent (Hu & Bentler, 1999; Author, Hau, & Wen, 2004; Author, Hau, & Grayson, 2005), such as the root mean square error of approximation (RMSEA), the Tucker-Lewis index (TLI), and the comparative fit index (CFI). Population values of TLI and CFI vary along a 0-to-1 continuum, in which values greater than .90 and .95 typically reflect acceptable and excellent fits to the data, respectively. Values smaller than .08 and .06 for the RMSEA support acceptable and good model fits, respectively.

The chi-square difference test can be used to compare two nested models, but this approach suffers from even more problems than does the chi-square test for single models in that it assumes that the best fitting models is based on a "true" model—problems that led to the development of other fit indices (see Author, Hau & Grayson, 2005). Cheung and Rensvold (2002) and Chen (2007) suggested that if the decrease in fit for the more parsimonious model is less than .01 for incremental fit indices such as the CFI, there is reasonable support for the more parsimonious model. For indices that incorporate a penalty for lack of parsimony, such as the RMSEA and the TLI, it is also possible for a more restrictive model to result in a better fit than would a less restrictive model. However, it is emphasized that these cut-off values constitute rough guidelines only, rather than "golden rules" (Author, Hau, & Wen, 2004).

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Factor analysis: Set-ESEM. CFA has largely superseded EFA, but a growing body of research shows that CFAs in applied research typically fail to provide an adequate goodness-of-fit and results in biased parameter estimates, due in part to overly restrictive CFAs in which each item loads on only one factor. In their Annual Review article on ESEM, Author et al (2014) present ESEM as as an integrative

framework that incorporates CFA/SEM and EFA as special cases. ESEM provides a good balance between the flexibility of EFA (in relation to measurement models) and the diverse applications possible with CFA/SEM that are typically not possible with traditional applications of EFA—including analyses in the present investigation. Indeed, in their original empirical introduction to ESEM, Author, et al. (2009) demonstrated its application based on SEEQ responses, establishing that compared to CFA, ESEM resulted in a better fit to the data and much better differentiation among the SEEQ factors, but still could be used in advanced statistical models such as tests of invariance. For present purposes, we treated responses made along a nine-point response scale as reasonably continuous rather than categorical, based on research showing that maximum likelihood estimation is more appropriate than alternative estimation procedures for Likert-type response scales with at least five response categories (Beauducel & Herzberg, 2006; DiStefano, 2002; Muthén & Kaplan, 1985; Rhemtulla, Brosseau-Liard & Savalei, 2012; Sass, Schmitt & Author, 2014). We also note that whereas number of items (58) is substantial in relation to the number of cases (761) in the largest models, simulation studies suggest that the quality of the results is based in part on the number of data points such that when N is modest, it is better to have more rather than fewer items (e.g., Author, Hau, Balla & Grayson, 1998; Velicer & Fava, 1998). However, because of the nature of the study, results from models with the largest number of factors were replicated in subsequent analyses based on responses to fewer items.

In some applications ESEM might lack parsimony (particularly in large, complex models based on moderate sample sizes) and confound constructs that need to be kept separate. Hence, Author et al. (2014), introduced set-ESEM that represents a middle ground between the flexibility of ESEM and the rigour of CFA/SEM. In Set-ESEM, two or more sets of constructs are modelled within a single model such that cross-loadings are permissible for constructs within the same set of factors (as in ESEM) but are constrained to be zero for factors in different sets (as in CFA). In their subsequent extension of ESEM to include Set-ESEM, Author, Guo et al. (2018; also see Author, Morin, et al., 2014) specifically noted the relevance of set-ESEM to MTMM data in which it is critical to not confound trait factors based on different instruments that would occur with ESEM (i.e., items from SEEQ could load on Endeavor factors, or vice-versa). The use of set-ESEM was noted as being particularly relevant for the analysis of MTMM data.

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Multitrait–multimethod (MTMM) analyses. Campbell and Fiske's (1959) MTMM paradigm is, perhaps, the most widely used construct validation design to assess convergent and discriminant validity, and is a standard criterion for evaluating psychological instruments—including U-SET surveys (Author, 1986; 2007).

Many 100s of MTMM studies have been based on the application of the original Campbell-Fiske guidelines (1959) to manifest correlation matrices based on scale scores, but these heuristic guidelines have been widely criticized. Although many alternatives to the original guidelines have been proposed (e.g., Author, 1989; Author & Grayson, 1995), none has been fully satisfactory nor achieved the broad popularity and application of the original guidelines. However, Author (Author, Martin & Hau, 2006; Author, Morin, et al., 2014) argued that most of the limitations of the original Campbell-Fiske guidelines are overcome when they are applied to a latent MTMM correlation matrix of factors representing all combinations of each trait and method (i.e., the factor analysis of SEEQ and Endeavor responses in Hypothesis 2A), and that this results in a more robust and heuristic evaluation of support for convergent and discriminant validity. Based on the set-ESEM extension of factor analyses and the extension of the Campbell-Fiske guidelines to a latent MTMM correlation matrix, we evaluate support for convergent and discriminant validity to responses based on matching SEEQ and Endeavor factors.

Results

Appropriateness and Importance of SEEQ, Endeavor, and Supplemental Items (Hypothesis 1).

Students rated an effective and a less effective teacher and indicated which items were inappropriate and most important. Results for all 104 items in the extended item pool, along with the wording of each item and the item content category, are presented in Appendix 1 and summarized in Table 1.

Inappropriate items. Across all 104 items (the "total category" in Table 1), the median number of not appropriate nominations was 0.8% and the highest number of nominations of any of the 104 items was 3.7%. Across the 15 item-content categories, the median number of inappropriate nominations was less than 1% for all but three categories (category 4, homework/assignments; 2.7%; category 10, breadth of coverage, 1.3%; and category 12, technology, 2.3%). These results indicate that secondary students felt that these S-SET items were appropriate. Indeed, these percentages for S-SET items seen to be inappropriately are considerably less than those reported in applicability studies for U-SET items reviewed by Author (1986) in which the mean percentage of inappropriate responses across all items varied from 3.7% to 5.3% in the different studies.

Most Important items. Across all 104 items (the "total category" in Table 1), the median number of times each item was nominated as "most important" was 6.9% and varied from 3% to 21.3% over the entire set of 104 items. There was, however, considerable variation among the 15 item-content categories. The most

important categories were: category 2, instructor enthusiasm, 17.7%; category 9, positive environment, 13.7%; category 1, learning/value, 11.3%; and category 6, Individual rapport, 10.7%. In contrast, the item-categories receiving the fewest nominations were: category 12, technology, 3.65%; and category 10 Breadth of coverage, 4.2%. This pattern of results is similar to those reported by Author (1986) across applicability studies based on university students in which individual rapport, instructor enthusiasm items were seen as most important, whilst reading/assignments, exams/grading, and breadth of coverage were seen as less important. However, it is notable that all items in both the university studies and the present investigation were seen as most important by some students.

Differentiation between good and poor teachers. The teachers chosen by secondary students as "effective" and "less effective" constitute criterion groups. Given the nature of the selection process, it is not surprising that "effective" teachers were rated higher than less effective teachers across the entire pool of 104 items (*Md* 7.68 vs 4.21). Again, however, the sizes of the differences varied substantially for the different categories. Based on the t-test differences as an index of differentiation, there were large differences for categories 1 (learning/value), 2 (instructor enthusiasm), and category 7 (organization/clarity). However, the largest differences were for the overall teacher and course ratings (category 14). The least differentiating factors were 12 (technology), 11 (classroom management), and particularly 15 (workload difficulty) where not even the direction of the differences was consistent across items. It should be noted that the selection process is likely to create a halo effect (i.e., "effective" teachers receive good ratings across all items) so that "differentiation" based on this criterion is, perhaps, a double-edged sword. Too little would suggest that ratings lacked validity but too much would likely undermine support for finding a well-defined multidimensional structure and convergent and discriminant validity in the MTMM analysis.

Factor Analysis of SEEQ and Endeavor Factors (Hypothesis 2).

SEEQ and Endeavor are designed to measure nine and seven factors respectively, a total of 16 factors. Based on potential limitations with both traditional approaches to EFA or CFA noted by Author (1986), here we introduce set-ESEM with target rotation. We note that ESEM with target rotation conceptually lies between the mechanical approach to EFA and the hypothesis-driven approach in CFA (see Browne, 2001) that is consistent with our application of ESEM as a hypothesis testing tool. Hence, there is an a priori basis for hypothesizing ESEM's superiority over CFA for SEEQ responses, but also the a priori factor structure for the ESEM that was defined by target and non-target items.

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Both CFA and set-ESEM analyses clearly identified all 16 SEEQ and Endeavor factors. Although the set-ESEM analysis resulted in a noticeably better fit to the data (M1 in Table 2; CFI = .969; TLI = .956; RMSEA = .036) the fit was surprisingly good even for more restrictive CFA (M2 in Table 2; CFI = .942; TLI = .935; RMSEA = .043). An inspection of the factor loadings (Table 3) demonstrates that all the factors were well identified as factor loadings relating each item to its intended factor are substantial (see summary of target loadings in Table 2; also see SM Table 1 for the full factor structure based on the set-ESEM). We note, however, that the CFA solution is technically improper in that one of the estimated factor correlations exceeds 1.0 (between the SEEQ Group Interaction and the Endeavor Group Discussion factors) and that many correlations among the 16 factors exceed .90 (see SM:Table 1). From this perspective, the SET-ESEM solution is clearly better (in subsequent presentation of results we focus on set-ESEM results but present a summary of the corresponding CFA results in SM). We note that this superiority of ESEM over CFA is consistent with Author (1986) results based U-SET research based on SEEQ.

MTMM analyses: Convergent and discriminant validity of SEEQ and Endeavor Responses (Hypothesis 3).

The SEEQ and Endeavor instruments were independently designed by different researchers and do not even measure the same number of components of teaching effectiveness. Nevertheless, a previous content analysis of the items and factors in each instrument (Author, 1986) suggests that there is a reasonable one-to-one mapping for the first six factors from each instrument (see Table 4). Correlations among these six factors from each instrument (in the bold box in Table 4) are taken to be convergent validities in terms of the MTMM analysis. As noted earlier, application of the original Campbell and Fiske's (1959) guidelines to a latent matrix of correlations among the 16 SEEQ and Endeavor factors (Tables 4) based on the set-ESEM analysis overcomes widely noted limitations to the use of these heuristic guidelines (See SM Tables 2 and 3 for a summary of results based on CFA).

Convergent validity. Support for convergent validity requires that correlations between the 6 matching SEEQ and Endeavor factors should be substantial. In Table 4 these are highlighted in the main diagonal of the square matrix within the bold box. There is clear support for this criterion in that all six convergent validities (see Tables 4 & 5) are statistically significant and substantial (rs = .86 to .94; M r = .90).

Discriminant validity. Within the Campbell-Fiske guidelines there are two main criteria used to assess discriminant validity. The first requires that the convergent validities (same traits measured by different instruments) are higher than correlations between non-matching SEEQ and Endeavor factors, the heterotrait-heteromethod correlations (HTHM; different traits and different methods; in Table 4 these for the off-diagonal values in the bolded box). There is clear support for this criterion in that the 30 HTHM correlations (*r*s .13 to .86, *M r* = .61, SEM = .04) are substantially smaller than the convergent validities (*M r* = .90). Campbell and Fiske (1959) also proposed that each convergent validity coefficient should be compared with all the other HTHM correlations involving the same traits. In the present investigation each of the six convergent validities is compared with 10 HTHM correlations, a total of 6 x 10 = 60 comparisons. Inspection of Table 4 shows that this criterion is met for all 60 comparisons.

The second criterion of discriminant validity is that convergent validities are higher than correlations among SEEQ factors and among Endeavor factors (heterotrait-monomethod, HTHM; different traits and same methods; in Table 4 these for the values below the main diagonal in the triangular submatrices that are shaded in light grey). Again, there is good support in that on average the convergent validities (*M r* = .90) are larger than the 30 HTMM correlations (.04 to .90; *M r* = .59). When each convergent validity coefficient was compared to the corresponding 10 HTMM correlations involving the same traits, the criteria is satisfied for 59 of the 60 comparisons; the one violation involves the correlation between Endeavor Group Interaction and Learning factors (.87) that is higher than the convergent validity for Group Interaction (.86).

Within the Campbell-Fiske framework it is also useful to test for halo effects within each of the multiple methods. This is identified by HTMM correlations being systematically higher than HTHM correlations. Here, however, the HTHM correlations (*M r* = .61) are marginally higher than the HTMM correlations (*M r* = .59). It is, however, relevant to note that 7 of 15 HTMM correlations among Endeavor are greater than .80, whereas only 1 of 15 HTMM correlations involving SEEQ is greater than .8. Thus, SEEQ factors appear to be better differentiated (less correlated) than the Endeavor factors.

Summary of MTMM analyses. In summary, the results provide very strong support for both the convergent and discriminant validity of responses to the matching SEEQ and Endeavor instruments. In particular, all six convergent validities are substantial and support for the two criteria of discriminant validity is met for 119 of 120 comparisons. We also note that these convergent validities are comparable – slightly higher – than those reported by Author (1986) for university applicability paradigm studies (*M r*s across four

studies varied from .72 to .87), and that satisfaction of tests of discriminant validity are also comparable or slightly better than those reported by Author (1986). Because of the somewhat different methodologies (SEEQ and Endeavor items were embedded within a larger pool of items here than in previous studies) and our use of set-ESEM, comparison of these results with those of earlier research need to be interpreted cautiously. However, even a cautious interpretation would suggest that support for convergent and discriminant validity in our study of S-SETs is as strong as previously reported for U-SET studies.

Selection of Items for the Final SEEQ-S Instrument (Hypothesis 4).

Total Group analysis. Applying the "best practice" approach to the development of a short form based on the entire item pool of 104 items (see Appendix 1, including SEEQ, Endeavor and additional items) we selected 51 items to represent 15 factors (the 10 factors based on SEEQ and Endeavor factors, plus five additional factors based on supplemental items—Relevance, Choice, Cognitive Activation, classroom management, technology). Criteria for item selection included items: seen to be appropriate and most important with student ratings, differentiating between more and less effective teachers, having high factor loadings on its target factors and low cross-loadings on other factors, maintaining the breadth of the factor and having low correlated uniquenesses with other items (i.e., high correlated uniquenesses suggest that two items are more correlated than can be explained in terms of the factors they are intended to measure; their inclusion tends to narrow the breadth of the factor and to distort the factor structure).

There was good support for the SET-ESEM factor structure (CFI = .975; TLI = .963; RMSEA = .034). The factors in the final SEEQ-S instrument were well identified in that items designed to measure each factor loaded substantially on that factor and less substantially on other factors (Table 6).

Upper and Lower Secondary Students.

Thus far our focus has been on the total group of secondary students. However, we hypothesized (Hypothesis 4b) that the factor structure would generalize well over responses to upper and lower secondary school classes. In support of our prediction, set-ESEM factor analyses provided very good support for the invariance (configural, metric, and scalar) of the factor structure over lower (Years 7 and 8) and upper (Years 9, 10, and 11) secondary school classes (Models 5 -7 in Table 1). The configural model (M5 in Table 1) provides a good fit to the data (CFL = .962, TLI = .943, RMSEA = .044). However, particularly for the TLI and RMSEA indices that take into account the added parsimony associated with the scalar model (M7), the scalar invariance model fit even better (CFL = .962, TLI = .952, RMSEA = .040) than the configural model.

Although not a major focus of the present investigation, the scalar invariance model also provides tests of latent mean differences across upper and lower secondary classes. Even though differences were small (Table 6; also see SM Table 4 for further detail), upper secondary classes had higher ratings for Group Interaction, Workload/Difficulty, and Cognitive Activation.

Discussion

The overarching purpose of the present investigation was to test the appropriateness to secondary school settings of instruments used to measure teaching effectiveness in university settings. This undertaking is important because there is a huge research literature in support of the validity and diagnostic usefulness of U-SETs, but a surprising lack of research on S-SETs. From the perspective of providing diagnostic feedback on relative strengths and weaknesses, a particularly important aspect of U-SET research is the identification of well-defined U-SET factors that are amenable to intervention to improve teaching effectiveness. This is particularly important in relation to existing research at the secondary school level where instruments such as the TRIPOD instrument, that has been the focus of much recent research, have been shown not to have a well-defined factor structure or the ability to differentiate among factors that they were designed to measure (Kuhfeld, 2017; Wallace et al., 2016).

In the U-SET literature, the "applicability paradigm" has been used to evaluate the appropriateness of two widely studied SET instruments (SEEQ and Endeavor) to different tertiary settings. Apparently, this paradigm from U-SET research has not previously been applied to secondary-school settings. Here we extend this research to evaluate the appropriateness of U-SET instruments in secondary settings. Secondary school students evaluated an "effective" and a "less effective" teacher on all items in a large item pool (SEEQ, Endeavor, and supplemental items) and rated the appropriateness and importance of each item. All items were seen as appropriate by nearly all students and were chosen as most important by at least some. Factor analysis of SEEQ and Endeavor responses supported their a priori factor structure, and multitriat-multimethod analyses provided support for their convergent and discriminant validity. Indeed, this support for S-SETs is as strong or stronger than found in the systematic review of U-SETs in tertiary settings (Author, 1986), suggesting the appropriateness of the instruments at the secondary level.

Adapting best practice to the development of short tests, the best 51 items were selected from the entire item pool of 104 items to represent 15 components of teaching effectiveness; the original 10 factors based on the SEEQ and Endeavor instruments (Learning/Value, Enthusiasm, Exams/Grading,

Homework/Assignments, Group Interaction, Individual Interaction, Breadth, Organizations/Clarity, Planning, Workload/Difficulty) and the five additional factors seen to be relevant to the secondary school setting (Relevance, Choice, Cognitive Activation, Classroom Management, Technology). Factor analysis supported the a priori 15 factors and demonstrated the invariance of the structure over younger and older secondary students.

Important weaknesses in the applicability paradigm have been identified (Author, 1986; 2007) that are also relevant to the present investigation. Thus, is it important to view the results in relation to these limitations. The applicability paradigm as adapted in the present investigation is intended as a first step in studying the generalizability of U-SET instruments to secondary school settings, and it should be evaluated within this context. The data generated by this paradigm seem to be useful for testing the applicability of the U-SET instruments and for refining an instrument that may be more suitable to a secondary setting; it is clearly preferable to adopting an untried instrument that has been validated in a very different setting. The paradigm is also cost-effective and practical in that (a) it requires only a modest amount of effort for data collection; (b) it can be conducted with volunteer subjects; (c) it does not require the identification of either the student completing the form or the instructor being evaluated and, therefore, is politically acceptable in most settings—a potentially contentious issue in secondary school settings. Of particular importance, it serves as an initial basis for further research and the eventual utilization of S-SETs.

Alternative approaches to studying the applicability of student ratings require researchers to administer surveys to all the students in a sufficiently broad cross section of classes so that class-average responses can be used in subsequent analyses (i.e., many 100s classes based on responses by many 1,000s students). Although such a large-scale effort is useful, it may not always be feasible. Furthermore, even when such a large-scale study is feasible, the applicability paradigm may provide a useful scoping study. Thus, in relation to large-scale studies such as those based on the TRIPOD instrument and the MET project that cost many millions of dollars, the applicability paradigm provides a useful basis for instrument construction. Indeed, particularly given that the research now suggests that the TRIPOD neither results in a well-defined multidimensional factor structure nor differentiates between components of teaching effectiveness that would be useful as diagnostic feedback, it appears that implementation of research along the lines of the applicability paradigm would have been a useful starting point for MET research.

Future Directions and Applications

We note that the present investigation is an important initial step in the broader application of S-SETs as a central component of a broader program to improve teaching effectiveness. However, an extensive discussion of the best use of S-SETs within the broader context of teacher evaluation and the specifics about their implementation are beyond the scope of this study. Nevertheless, there are a host of important directions for further research based on the SEEQ-S, many of which follow the extensive research based on the SEEQ at the university level (Author, 2007) and U-SET research more generally. Most importantly, the appropriate unit of analysis is the teacher/class combination (i.e., class-average ratings) rather than the individual student. Historically, analyses have been based on class-average responses, but methodology has evolved such that best practice is doubly latent multi-level models (Author et al., 2009) that take into account the nested structure of the data while correcting for measurement and sampling error within the whole sample as recommended by Kuhfeld (2017), Schweig (2014), Wallace et al. (2016), and others. The applicability paradigm finesses this issue in part by a selection process in which relatively few students are likely to select the same class so that most classes are rated by a single student. Although expedient, this approach means that the relative agreement among students within the same class (and associated measures of interrater agreement and reliability at the class-average level) cannot be assessed. Hence, there is need for a large-scale study that includes at least several hundred intact classes that will provide an appropriate dataset for further large-scale evaluation of the newly developed SEEQ-S instrument using state of the art doubly latent multi-level models. There is also a related issue in that each student rated two classes so that classes are nested within students. In the present investigation this issue was handled using the complex design option in Mplus that adjusts standard errors to take account this clustering of classes within students. We note however, that in practice this issue is usually ignored; even though the same student might evaluate several different classes, students are anonymous so that this potential clustering cannot be modelled. Although this issue is a relevant statistical concern, it is also substantively relevant to address potential method, halo, and response set issues associated with responses by individual students that have been largely ignored in both U-SET and S-SET research literatures.

Future research based on S-SETs needs to pursue further research with SEEQ-S that parallels the extensive U-SETs literature in relation to reliability, validity, potential biases, and usability (see Author, 2007). The MTMM paradigm can be expanded to test generalizability and validity as has been done in U-SET research. For example, MTMM studies of agreement between ratings of the same teacher in different

classes and different teachers teaching the same class test the generalizability of the ratings over different classes and groups of students. For U-SETs this research suggests that U-SETs reflect the teacher teaching the course rather than the class being taught (Author, 2007). This is important in supporting the use of U-SETs as a measure of teaching effectiveness and the aggregation of results by the same teacher over different classes (Author, 2007). MTMM studies of SEEQ-S ratings by students and teachers test the validity of S-SETS. For U-SETs the research shows support for convergent and discriminant validity, but is also valuable in relation to interventions designed to improve teaching effectiveness that are based in part on teacher self-evaluations. A critical direction for further research is to relate SEEQ-S at the level of the teacher to class-average achievement. In U-SET research the multisection validity paradigm has been used to address this issue, but may not be relevant to secondary school settings where many multiple sections of the same courses are not typical. Clearly it is relevant to relate class-average SEEQ-S responses to appropriate value-added measures of achievement, but this is based on the apparently problematic assumption that good measures of value-added achievement are available (Darling-Hammond, 2013; Stecher et al., 2018; Van der Lans et al., 2015). In the U-SET literature there is extensive and contentious debate on potential biases to U-SETs—indeed as to what constitutes a bias rather than a valid source of influence that is accurately reflected in the U-SETs. Although a systematic review of this literature is clearly beyond the scope of the present investigation (see Author, 1987; 2007), this U-SET research might provide a useful starting point for evaluating potential biases in S-SET research. We also note that there is good psychometric support for the 15 SEEQ-S factors in relation to factor structure as well as face validity. However, although SEEQ research provides clear support for the usefulness of many of these factors at the university level, there is need for further research as to their usefulness in secondary school settings. Indeed, it is interesting to note that the additional five factors selected as being particularly relevant for secondary school settings were not among the "most important" factors based on student ratings of the importance of each item (Appendix 1). However, support for their retention must come from further research on the reliability, validity, and usefulness in relation to feedback to teachers to improve teaching effectiveness.

An important focus of U-SET research that has been largely ignored in S-SET research is the use of student ratings to improve teaching effectiveness. Thus, for example, Author (2007b; Author & Roche, 1993) developed and tested a prototype feedback/consultation based on the SEEQ instrument. Critical features of this intervention were baseline SEEQ data collected prior to the intervention, teacher self-

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evaluations of their teaching effectiveness using the same SEEQ instrument and the importance of the different SEEQ factors in relation to their teaching effectiveness and its improvement, the set idea books (one for each SEEQ factor) of strategies to improve teaching effectiveness, and the individual face-to-face consultation with an external consultant who facilitated the teacher's interpretation of the results and selection strategies. Although this approach seems to be appropriate to S-SET research, particularly the idea book of strategies related to each SEEQ-S factor would need to be substantially revised and extended to include the new SEEQ-S factors not included on U-SEEQ.

In summary, there is good support for the appropriateness of U-SET instruments for secondary school settings. Indeed, support for the appropriateness, importance, convergent validity and divergent validity of S-SETs found here is as strong or stronger than that found in previous applicability studies of U-SETs. In contrast to much previous secondary research that has been unable to identify well-defined factors of teaching effectiveness, factor analysis of the S-SEEQ responses supports the 15 a priori factors that the instruments was designed to measure. Despite the obvious limitations of the applicability paradigm, the results provide a solid foundation to pursue further research at the secondary level that parallels the extensive research into reliability, validity, bias, and usefulness at the university level.

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Table 1

Summary of Appropriateness, Importance, and Differences for Categories in the Extended Set of Items

Summary	Category	% not Appro	% Impt	Mean good	Mean poor	Diff tttest	corr		Category	% not Appro	% Impt	Mean good	Mean poor	Diff tttest	corr
Median	1 (7)	0.30	11.30	7.89	4.12	27.95	-0.09		9 (2)	0.35	13.70	8.05	4.51	24.67	-0.03
Mean		0.49	9.76	7.90	3.97	26.66	-0.09			0.35	13.70	8.05	4.51	24.67	-0.03
Minimum		0.10	4.40	7.61	3.13	21.88	-0.14			0.30	13.50	8.03	4.12	21.25	-0.03
Maximum		1.40	14.10	8.23	4.51	31.29	-0.02			0.40	13.90	8.07	4.89	28.09	-0.03
Median	2 (5)	0.40	17.70	8.01	3.64	25.77	-0.06		10 (7)	1.30	4.20	7.70	4.09	24.56	-0.10
Mean		0.36	17.46	7.98	3.80	27.70	-0.05			1.44	4.60	7.62	4.10	24.85	-0.09
Minimum		0.30	12.60	7.64	3.07	24.60	-0.07			1.20	3.00	7.35	3.81	22.47	-0.14
Maximum		0.40	21.30	8.25	4.44	33.03	-0.02			1.90	6.70	7.79	4.44	26.82	-0.03
Median	3 (7)	0.80	8.10	7.83	4.68	21.31	0.03		11 (8)	0.35	9.45	5.70	4.74	5.16	-0.06
Mean		1.19	8.33	7.83	4.59	22.20	0.04			0.48	9.75	5.61	4.82	6.08	-0.05
Minimum		0.50	6.00	7.73	4.09	18.67	-0.02			0.10	6.30	3.52	3.84	-11.36	-0.09
Maximum		2.60	11.60	7.90	5.07	26.80	0.08			1.20	13.80	7.73	5.94	27.31	0.01
Median	4 (6)	2.70	6.55	7.45	4.42	19.74	-0.03		12 (6)	2.30	3.65	7.18	4.31	17.07	-0.09
Mean		2.65	6.38	7.51	4.56	19.88	-0.03			2.23	3.77	7.20	4.39	17.27	-0.09
Minimum		1.80	3.30	7.31	3.99	17.50	-0.11			1.20	3.20	7.05	4.18	15.42	-0.14
Maximum		3.30	9.60	7.96	5.61	22.31	0.10			2.90	4.90	7.38	4.83	18.96	-0.04
Median	5 (7)	0.80	8.00	7.95	4.49	23.80	-0.02		13 (23)	0.90	5.80	7.49	4.05	22.13	-0.08
Mean		0.70	7.96	7.92	4.43	24.32	-0.04			1.20	6.32	7.46	4.12	22.34	-0.08
Minimum		0.10	6.70	7.77	4.04	23.35	-0.14			0.10	3.20	5.91	3.06	0.54	-0.18
Maximum		1.10	9.30	8.00	4.69	28.16	0.03			3.70	16.70	8.08	5.87	31.93	0.01
Median	6 (7)	0.50	10.70	7.98	4.23	24.01	-0.12		14 (2)	0.15		7.67	2.99	33.52	-0.21
Mean		0.73	10.93	7.88	4.24	23.79	-0.09			0.15		7.67	2.99	33.52	-0.21
Minimum		0.40	7.60	7.66	3.83	21.37	-0.16			0.00		7.43	2.82	29.07	-0.22
Maximum		1.70	13.60	8.06	4.80	26.57	0.01			0.30		7.91	3.15	37.96	-0.20
Median	7 (8)	0.60	7.65	7.76	4.02	26.04	-0.06		15 (6)	0.55		5.24	4.99	2.11	0.01
Mean		0.84	7.80	7.75	4.08	25.90	-0.07			0.70		5.21	4.67	3.64	0.03
Minimum		0.10	3.30	7.51	3.42	16.06	-0.14			0.10		3.14	2.80	0.23	-0.05
Maximum		2.40	13.90	7.99	4.90	32.67	-0.03			1.90		6.99	5.26	11.30	0.19
Median	8 (5)	0.80	6.20	7.63	4.24	22.40	-0.05		Total (104)	0.80	6.90	7.68	4.21	23.09	-0.06
Mean		0.66	6.62	7.62	4.23	22.59	-0.06			1.03	8.09	7.37	4.27	21.01	-0.06
Minimum		0.40	5.50	7.45	3.99	21.12	-0.14			0.00	3.00	3.14	2.80	-11.36	-0.22
Maximum		0.80	8.70	7.75	4.49	24.79	0.01			3.70	21.30	8.25	5.94	37.96	0.19

Note. For each of the 104 items in the extended item pool, students rated a good and a poor teacher and indicated which items were inappropriate and most important. For each set of items, we list the Category and, in parentheses, the number of items in the category. The 15 categories refer to items designed to reflect 1, learning/value; 2, teacher enthusiasm; 3, exams/grading; 4, homework/assignments, 5; group interaction; 6, individual interaction; 7, organizations/clarity; 8, planning; 10, breadth of coverage; 15, workload/difficulty; 14, SEEQ global rating items, 9, learning environment; 11, classroom management/control; 12, technology; 13, self-determination items used to define Cognitive Activation, Choice and Relevance. See Appendix 1 for wording of items; % not Appro= Percentage items in category judged to be inappropriate; %Impt = Percentage items in category judged to be most important; Mean good = mean rating of the good classes; Mean poor = mean rating of the poor classes; =Diff test= T-test different between good and poor classes; corr = correlation between ratings of the good and poor classes by each student.

Table 2: Goodness-of-Fit Indices for Invariance Models: Multigroup (based on year in school**)**

Model	ChiSq	*df*	Parms	RMSEA	CFI	TLI	Description
SEEQ+Endeavor—Total group							
M1 TG–ESEM	2396	1216	633	.036	.969	.956	Total Group
M2 TG–CFA	3727	1531	298	.043	.942	.935	Total Group
Final SEEQ-S Instrument (Selected Items from SEEQ, Endeavor & item pool) —Total group							
M3 TG–ESEM	1599	849	528	.034	975	.963	Total Group
M4 TG–CFA	2781	1118	259	.044	945	.937	Total Group
Final SEEQ-S —Invariance Over upper/lower secondary school							
M5 MG–ESEM-	2929	1698	1056	.044	962	.943	Configural
M6 MG–ESEM-	3223	2003	751	.040	962	.952	Metric
M7 MG–ESEM-	3223	2003	751	.040	962	.952	scalar

Note. Summary of Goodness-of-fit statistics for the different factor analyses considered in the present investigation, TG=total group; MG = multi-group (based on year in school); ESEM = exploratory factor analysis; CFA = confirmatory factor analysis; Parms = number of freely estimated parameters; *Chi*-Sq = chi-square; df = degrees of freedom ratio; CFI = Comparative fit index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation. All analyses were done with robust maximum likelihood estimator and type = complex to account for the clustering classes within students (i.e., each student rated two classes).

Table 3

Completely Standardized Target Factor Loadings for SEEQ (S) and Endeavor (E) Instruments: Confirmatory Factor Analysis (CFA) and Exploratory Structural Equation Modeling (ESEM)

SEEQ Factor Loadings					Endeavor Factor Loadings			
			CFA	EESEM			CFA	ESEM
SLRN	Q1P1	.785	.333		ELRN	Q1P5	.931	.680
	Q1P2	.891	.451			Q1P6	.912	.573
	Q1P3	.888	.385			Q1P7	.916	.822
	Q1P4	.865	.669		EEXM	Q3P4	.824	.836
	OvClass	.848	.426			Q3P5	.920	.865
SEXM	Q3P1	.860	.433			Q3P6	.925	.922
	Q3P2	.848	.965		EGRP	Q5P5	.892	.808
	Q3P3	.815	.290			Q5P6	.887	.903
SGRP	Q5P1	.905	.696			Q5P7	.858	.763
	Q5P2	.845	.729		EIND	Q6P5	.916	.589
	Q5P3	.905	.339			Q6P6	.901	.629
	Q5P4	.866	.493			Q6P7	.901	.931
SIND	Q6P1	.838	.642		ECLR	Q8P2	.848	.452
	Q6P2	.925	.602			Q8P3	.920	.355
	Q6P3	.871	.582			Q8P4	.856	.258
	Q6P4	.835	.555		EWRK	INTEN	.684	.673
SORG	Q7P1	.906	.357			TIME	.847	.887
	Q8P1	.886	.470			WORK	.844	.901
	Q7P2	.907	.556		EORG	Q7P5	.917	.452
	Q7P3	.904	.499			Q7P6	.887	.355
	Q7P4	.622	.184			Q7P7	.824	.258
SWRK	DIFF	.526	.748					
	HOURS	.576	.722					
	PACE	.539	.658					
SBRD	Q10P1	.868	.373					
	Q10P2	.894	.235					
	Q10P3	.868	.438					
	Q10P5	.817	.430					
	Q10P4	.867	.173					
SENT	Q2P1	.882	.759					
	Q2P2	.928	.610					
	Q2P3	.824	.534					
	Q2P4	.926	.450					
	OvTeach	.910	.444					
SASG	Q4P1	.904	.997					
	Q4P2	.828	.737					
	Q4P3	.913	.796					
	Q4P6	.729	.654					

Note. Target loadings for CFA and Set ESEM factor analysis of the combined set of items representing the SEEQ and Endeavor instruments (see Table 2 for goodness of fit; Table 4 for factor correlations; and Appendix 1 for wording of the items). In the set-ESEM, items from each instrument were allowed to cross-load on other factors from the same instrument but cross-loadings from items from one instrument to the other instrument were constrained to be zero (see SM:Table 1 for the complete matrix of factor loadings, including the cross-loadings). In the CFA, there were no cross-loadings (i.e., all non-target cross-loadings were constrained to be zero).

Table 4

Multitrait-multimethod Matrix

	SLRN	SEXM	SGRP	SIND	SORG	SWRK	SBRD	SENT	SASG	ELRN	EEXM	EGRP	EIND	ECLR	EWRK	EORG
SEEQ (S) Factors																
SLRN	*1.0*															
SEXM	.57	*1.0*														
SGRP	.52	.56	*1.0*													
SIND	.81	.56	.35	*1.0*												
SORG	.65	.60	.71	.65	*1.0*											
SWRK	.32	.53	.42	.31	.48	*1.0*										
SBRD	.52	.63	.06	.68	.41	.39	*1.0*									
SENT	.55	.75	.75	.52	.78	.58	.49	*1.0*								
SASG	.76	.74	.69	.69	.85	.58	.53	.78	*1.0*							
Endeavor (E) Factors																
ELRN	.94	.68	.65	.78	.85	.48	.54	.72	.84	*1.0*						
EEXM	.70	.91	.59	.71	.71	.49	.57	.69	.83	.78	*1.0*					
EGRP	.78	.76	.86	.76	.84	.51	.56	.82	.86	.87	.82	*1.0*				
EIND	.80	.66	.62	.92	.86	.46	.64	.75	.82	.88	.78	.90	*1.0*			
ECLR	.69	.71	.63	.70	.93	.53	.53	.81	.88	.83	.78	.83	.83	*1.0*		
EWRK	.19	.30	.28	.13	.30	.86	.16	.34	.37	.27	.26	.28	.25	.32	*1.0*	.17
EORG	.52	.89	.60	.42	.54	.50	.69	.86	.73	.65	.68	.76	.60	.70	.30	*1.0*

Note. Multitrait-multimethod matrix of correlations between matching SEEQ and Endeavor factors (shown in rectangles outlined in bold). Convergent validities (highlighted in the diagonal of bolded box) are all statistically significant and consistently higher than correlations involving non-matching factors: heterotrait-heteromethod (different trait, different method) correlations between non-matching SEEQ and Endeavor factors (off-diagonal values in the bolded box) and heterotrait-monomethod (different trait, same method) correlations among SEEQ factors and Endeavor factors (off-diagonal values within each of the triangular submatrices correlations among SEEQ factors and among Endeavor factors (highlighted in light gray). Corresponding values base on the CFA solution are presented in SM:Table 3.

Table 5
Summary of Multitrait-Multimethod (MTMM) Analyses: Convergent and Discriminant Validity to Responses to SEEQ and Endeavor instruments

Type of Coefficient	No. of corrs	Median	Mean	SE of Mean	Min	Max
Convergent Validity correlations	6	.92	.90	.01	.86	.94
HTMM Heterotrait Monomethod correlations	30	.59	.59	.04	.25	.90
HTHM Heterotrait Heteromethod correlations	30	.67	.61	.04	.13	.86
Other correlations	54	.67	.63	.02	.06	.89
Total	120	.67	.63	.02	.06	.94

Note. Summary of correlations based on the MTMM matrix (Table 4). No.of correlations is the number of correlations falling into each category. Other correlations refer to those involving the three SEEQ factors that did not match any of the Endeavor factors or the one Endeavor factor that did not match any SEEQ factors. Corresponding results based on the confirmatory factor analysis results are presented in SM:Table 5.

Table 6
Standardised Factor Loadings, Factor Correlations, and Factor Mean Differences based on the Final SEEQ-S Instrument

	Lm	Ent	Exm	Asg	Grp	Ind	Org	Pln	Brd	Wrk	Rel	Cho	Cog	Mang	Tech
Learning															
Q1.2	.59	-.03	-.11	.13	-.09	.29	.03	.24	.12	-.02					
Q1.4	.75	-.06	-.12	.11	.01	.21	.02	.36	-.04	-.07					
over class	.36	.38	.08	.07	-.04	-.04	.03	.13	.04	.03					
Q1.7	.64	.00	.12	.02	.13	-.06	.05	.43	-.07	.04					
Enthusiasm															
Q2.1	-.20	.89	.01	.05	.05	-.10	.02	.22	.13	.00					
Q2.2	.15	.68	-.07	-.02	-.05	.11	-.01	.14	.14	.00					
over teach	.26	.39	.15	-.15	-.02	.10	.04	.10	.17	.05					
Q2.5	-.01	.97	-.10	.06	.03	.16	.02	-.03	-.23	.03					
Exams/Grading															
Q3.1	-.03	.06	.80	.15	-.01	-.01	-.03	.20	-.04	.00					
Q3.2	.05	-.05	.64	.13	.22	.28	.02	.00	-.39	.01					
Q3.7	-.13	-.02	.82	.10	-.26	.16	-.03	.32	.22	-.02					
Homework/Assignments															
Q4.1	.09	-.10	.01	.82	-.02	.02	.11	-.18	.09	.04					
Q4.2	.10	.03	.28	.68	.21	-.28	-.01	-.01	-.08	.00					
Q4.3	.02	-.04	.04	.83	-.04	-.01	.02	-.17	.23	-.01					
Group Interaction															
Q5.2	.04	.00	-.08	.05	.76	.02	-.02	.11	.14	-.03					
Q13.14	-.09	.03	.13	.00	.61	.24	-.04	-.01	.08	.00					
Q5.7	-.06	-.06	-.15	.11	.82	.05	-.04	-.04	.30	-.04					
Individual Interaction															
Q6.2	-.04	.14	.19	-.08	.09	.75	.07	-.24	-.05	.04					
Q6.5	.05	.00	.12	-.11	.15	.70	.06	-.10	.07	.03					
Q13.23	.30	.10	.09	-.06	.07	.51	-.02	.03	.03	-.03					
Organization/Clarity															
Q8.2	-.08	-.07	.03	.05	.00	.00	.92	.18	-.04	-.01					
Q8.3	.15	.13	-.12	.12	-.10	.10	.51	.08	.12	.02					
Q8.4	-.05	-.02	.02	-.01	.02	.02	.86	.15	-.04	.03					
Planning															
Q7.5	.41	.17	.18	-.07	.20	-.13	.05	.30	.09	.03					
Q7.6	.18	.08	.20	-.09	.04	-.04	.11	.43	.34	.00					
Q7.7	.04	.00	.05	-.08	.01	.05	.18	.36	.53	.01					
Q7.1	.42	.23	.06	.10	-.08	.01	.10	.21	.13	-.07					
Breadth of Coverage															
Q10.1	-.11	.09	.04	-.05	.18	.08	-.18	.35	.78	-.02					
Q13.4	.10	-.01	-.05	.02	.11	-.04	.15	.34	.40	.17					
Q10.4	.07	.10	-.09	.29	.01	.06	-.05	.15	.56	-.06					
Q10.5	-.09	.01	-.09	.00	.21	-.02	.14	.27	.59	.07					
Workload/Difficulty															
DIFF	-.28	.01	-.03	-.03	-.01	.00	.14	-.24	.08	.59					
INTENS	.18	.11	-.02	-.07	-.05	-.04	.12	.01	-.04	.74					
TIME	-.01	-.13	-.01	.01	-.02	.04	-.19	-.02	.02	.89					
WORK	.00	-.04	-.06	.01	-.09	-.08	-.14	.04	.02	.91					

Table 6 cont

	Lrn	Ent	Exm	Asg	Grp	Ind	Org	Org	Brd	Wrk	Rel	Cho	Cog	Mang	Tech
Relevance															
Q13.9											.90	-.20	.20	-.02	-.07
Q13.10											.85	.05	-.05	.06	.06
Q13.12											.87	.18	-.09	.08	-.04
Choice															
Q13.8											.13	.64	.09	.08	.10
Q13.11											.09	.76	-.03	.18	.12
Q13.17											-.09	1.02	.14	.14	-.10
Cognitive Activation															
Q13.7											-.10	-.09	1.06	.02	-.04
Q13.13											.04	.09	.83	.07	-.04
Q13.21											.10	.10	.49	.05	.19
Classroom Management															
Q11.3											.11	.32	.09	-.44	.08
Q11.5											.05	-.06	-.01	.68	-.06
Q11.6											-.07	-.10	.00	.53	.07
Q11.8											-.05	.19	-.03	.74	-.05
Technology															
Q12.2											.05	.03	.08	.04	.76
Q12.4											-.01	-.05	.00	.02	.99
Q12.5											-.07	.08	.07	.04	.84

Factor Correlations

	Lrn	Ent	Exm	Asg	Grp	Ind	Org	Org	Brd	Wrk	Rel	Cho	Cog	Mang	Tech
Lrn	1.														
Ent	.77	1.													
Exm	.83	.80	1.												
Asg	.63	.77	.65	1.											
Grp	.70	.81	.77	.71	1.										
Ind	.60	.83	.66	.86	.76	1.									
Org	.76	.83	.81	.74	.75	.74	1.								
Eorg	-.05	.31	.06	.54	.35	.55	.23	1.							
Brd	.86	.82	.85	.65	.75	.67	.83	-.02	1.						
Wrk	.22	.36	.29	.43	.32	.37	.36	.29	.33	1.					
Impt	.78	.85	.77	.81	.76	.81	.79	.33	.83	.35	1.				
Choice	.78	.91	.83	.77	.82	.85	.84	.28	.91	.32	.88	1.			
Reflect	.70	.79	.74	.76	.86	.77	.73	.37	.75	.39	.83	.84	1.		
Manage	-.52	-.47	-.48	-.30	-.37	-.22	-.53	.00	-.46	-.24	-.39	-.45	-.36	1.	
Tech	.66	.72	.65	.73	.69	.75	.72	.28	.77	.27	.79	.82	.75	-.29	1.

Factor Mean Differences(Older-Younger Group) [a]

	Lrn	Ent	Exm	Asg	Grp	Ind	Org	Org	Brd	Wrk	Rel	Cho	Cog	Mang	Tech
MeanDiff	-.05	.07	.10	-.04	.15	.07	-.03	-.11	.18	.29	.03	.08	.12	-.02	.03
SEDiff	.13	.05	.10	.09	.07	.07	.07	.22	.13	.07	.05	.05	.05	.08	.06

Note. ESEM factor analysis of the Final SEEQ-S instrument (Model M3 in Table 1), including items from the SEEQ and Endeavor instruments, as well as additional factors selected specifically for this study. See Appendix 1 for the wording of items. Highlighted items are the target loadings of items designed to measure each factor.
[a] Latent mean differences are based on model of scalar invariance of factor structure over older (years 8, 9 and 10) and younger students (years 7 and 8); see model M7 in Table 1 .

Appendix 1
Item Characteristics of the Pool of Items

Items	Not Appro	Impt	M Better	M Poorer	M Diff	SE Diff	t-test	Corr
1.1 You found the class intellectually challenging and stimulating	0.003	0.114	7.61	4.19	3.478	.159	21.88	-.136
1.2 You have learned something which you considered valuable	0.003	0.113	7.94	4.12	3.850	.152	25.38	-.024
1.3 Your interest in the subject has increased as a consequence of this class	0.005	0.141	7.74	3.13	4.680	.150	31.29	-.090
1.4 You have learned and understood the subject materials in this class	0.003	0.069	8.08	4.51	3.591	.152	23.69	-.084
1.5 It is now easier for me to understand the advanced material	0.005	0.076	7.79	3.71	4.120	.147	27.95	-.124
1.6 The teacher has developed my ability to analyse issues in this subject	0.014	0.044	7.89	3.89	4.014	.142	28.34	-.143
1.7 This class has increased my knowledge and competence in this area	0.001	0.126	8.23	4.21	4.067	.145	28.09	-.029
2.1 The teacher was enthusiastic about teaching the class	0.003	**0.213**	8.14	4.21	3.962	.154	25.77	-.062
2.2 The teacher was dynamic and energetic in teaching the class	0.003	0.126	8.01	3.64	4.390	.149	29.39	-.061
2.3 The teacher enhanced lessons with the use of humour	0.004	0.158	7.64	3.63	4.025	.164	24.60	-.061
2.4 The teacher's style of teaching held my interest during class	0.004	**0.177**	7.87	3.07	4.860	.147	33.03	-.069
2.5 The teacher seems to enjoy teaching	0.004	**0.199**	8.25	4.44	3.840	.149	25.71	-.018
3.1 Feedback on assessments/ marked material was valuable	0.016	0.116	7.90	4.10	3.847	.144	26.80	.029
3.2 Methods of assessing student work were fair and appropriate	0.007	0.068	7.86	4.82	3.079	.146	21.02	.066
3.3 Assessments/ Examinations tested class content as emphasised by the teacher	0.014	0.066	7.78	4.68	3.119	.144	21.60	-.020
3.4 The marking system in this class was fair and partial	0.008	0.081	7.90	5.07	2.855	.153	18.67	.010
3.5 The marking accurately reflected the student's performance	0.007	0.087	7.79	4.69	3.133	.150	20.89	.025
3.6 The marking procedure fairly indicated each student's accomplishments	0.005	0.060	7.73	4.68	3.075	.144	21.31	.079
3.7 Feedback on assignments were useful	0.026	0.105	7.83	4.09	3.754	.149	25.13	.061
4.1 Homework, assignments etc. were valuable	0.025	0.096	7.39	4.16	3.379	.153	22.07	-.052
4.2 Homework, assignments etc. contributed to appreciation and understanding of the class	0.018	0.063	7.48	4.21	3.320	.159	20.91	-.112
4.3 Homework, assignments etc. encouraged further learning	0.029	0.054	7.43	3.99	3.541	.159	22.31	-.095
4.4 Homework, assignments etc. were integrated into class	0.024	0.033	7.46	4.74	2.757	.148	18.57	-.015
4.5 Homework, assignments etc. were appropriate in length and difficulty	0.030	0.068	7.31	4.63	2.701	.151	17.90	.005
4.6 Homework, assignments etc. were related to class work	0.033	0.069	7.96	5.61	2.370	.135	17.50	.095
5.1 Students were encouraged to participate in class discussions	0.011	0.080	8.00	4.52	3.494	.148	23.54	-.091
5.2 Students were invited to share their ideas and knowledge	0.007	0.067	7.95	4.69	3.296	.137	24.07	.029
5.3 Students were encouraged to ask questions and were given meaningful answers.	0.001	0.073	7.92	4.04	3.910	.139	28.16	-.016
5.4 Students were encouraged to express their own ideas and / or question The teacher.	0.008	0.093	7.77	4.21	3.611	.152	23.80	-.137

5.5 Class discussion was welcome in this class	0.009	0.087	8.00	4.47	3.538	.148	23.89	-.013
5.6 The students were actively encouraged to participate in class discussion	.008	.084	7.97	4.58	3.416	.146	23.35	-.078
5.7 Students were encouraged to openly express ideas	.005	.073	7.82	4.49	3.353	.143	23.44	-.006
6.1 The teacher was friendly towards individual students	.004	.134	8.06	4.80	3.268	.153	21.37	.012
6.2 The teacher made students feel welcome in seeking help / advice in or outside of class	.005	.107	8.01	4.11	3.959	.158	25.05	-.127
6.3 The teacher had a genuine interest in individual students	.008	.136	7.78	3.99	3.831	.163	23.52	-.164
6.4 The teacher was adequately accessible to students during office hours or after class	.017	.076	7.66	4.35	3.335	.156	21.38	-.070
6.5 The teacher listened to each student's problems and was willing to help	.005	.107	8.03	4.23	3.859	.145	26.57	-.035
6.6 The student was able to get personal help in this class	.005	.120	7.98	4.40	3.611	.150	24.01	-.120
6.7 The teacher was genuinely concerned about each student's difficulties	.007	.085	7.67	3.83	3.829	.156	24.61	-.118
7.1 The teacher's explanations were clear	.001	.139	7.99	3.79	4.225	.138	30.64	-.080
7.2 Class materials were well prepared and carefully explained	.001	.085	7.82	4.03	3.803	.143	26.61	-.135
7.3 Proposed objectives agreed with those actually taught so you knew where the class was going	.024	.033	7.62	4.00	3.672	.145	25.37	-.115
7.4 The teacher gave lessons that facilitated taking notes	.014	.078	7.51	4.90	2.660	.166	16.06	-.027
7.5 The teachers' style helped to clarify the class material	.004	.075	7.86	3.42	4.461	.137	32.67	-.085
7.6 The teacher presented material clearly and summarized major points	.005	.087	7.92	4.18	3.770	.140	26.97	-.026
7.7 The teacher made good use of examples and illustrations	.007	.059	7.70	4.33	3.411	.146	23.39	-.049
8.1 Class objectives were stated and pursued	.011	.068	7.61	4.00	3.638	.143	25.47	-.034
8.2 Each class period was carefully planned in advance	.004	.087	7.75	4.43	3.359	.148	22.77	-.052
8.3 The teacher organized the class activities in a detailed fashion	.008	.055	7.69	4.02	3.691	.149	24.79	-.135
8.4 Class activities were scheduled in an orderly way	.008	.068	7.63	4.49	3.168	.145	21.88	.009
8.5 The teacher distributed the materials well over different topics	.008	.059	7.59	4.24	3.373	.160	21.12	-.106
8.6 The teacher announced lessons goals and/or criteria	.005	.062	7.45	3.99	3.482	.155	22.40	-.018
9.1 There was a friendly atmosphere in this class	.003	.139	8.07	4.89	3.186	.150	21.25	-.032
9.2 There was a positive learning environment in this class	.004	.135	8.03	4.12	3.900	.139	28.09	-.027
10.1 The teacher compared ideas from various points of view	.016	.042	7.35	3.81	3.575	.146	24.56	-.139
10.2 The teacher gave the background for ideas / concepts presented in class	.013	.050	7.79	4.21	3.668	.137	26.68	-.143
10.3 The teacher gave different points of view when appropriate	.012	.041	7.76	3.94	3.857	.144	26.82	-.097
10.4 The teacher adequately discussed current developments of the subject	.019	.030	7.48	4.09	3.429	.145	23.72	-.033
10.5 The teacher raised challenging questions or problems for discussion	.012	.067	7.70	4.44	3.294	.147	22.47	-.060
11.1 The teacher kept the class orderly and working well	.004	.078	7.73	3.84	3.947	.145	27.31	-.088

11.2 The teacher was effective in handling disruptive students	.012	.082	7.39	4.23	3.18	.166	19.19	-.079
11.3 The teacher had good classroom control	.004	.112	7.62	4.06	3.61	.156	23.16	-.042
11.4 The teacher started lessons on time and finishes on time	.003	.063	7.48	4.62	2.90	.171	16.98	-.056
11.5 In this class there was a lot of noise and disorder	.003	.138	4.01	5.94	-1.95	.176	-11.10	.008
11.6 In this class, a lot of lesson time was wasted	.001	.134	3.52	5.73	-2.25	.198	-11.36	-.053
11.7 In this class, the teacher had to shout to be heard	.003	.066	3.54	4.85	-1.33	.200	-6.67	-.055
11.8 The teacher was slow to correct disruptive behavior	.008	.107	3.58	5.28	-1.67	.189	-8.87	-.064
12.1 The teacher made effective use of new information/ communication technologies (e.g., internet, computers, smart phones in the classroom as appropriate	.012	.039	7.37	4.42	3.00	.164	18.30	-.137
12.2 The teacher used new information/ communication technologies (e.g., internet, computers, smart phones) to introduce students to real world scenarios.	.029	.033	7.08	4.33	2.82	.168	16.77	-.080
12.3 The teacher helped/ encouraged us to use information/ communication technologies (e.g., internet, computers, smart phones) to find information on our own	.018	.049	7.38	4.83	2.569	.167	15.42	-.108
12.4 The teacher helped/ encouraged us to use information/ communication technologies (e.g., internet, computers, smart phones) to plan and monitor our own learning	.028	.032	7.06	4.29	2.835	.167	17.01	-.094
12.5 The teacher helped/ encouraged us to use information/ communication technologies (e.g., internet, computers, smart phones) to show results of our work	.029	.036	7.05	4.18	2.898	.169	17.13	-.065
12.6 The teacher helped/ encouraged us to collaborate with each other using information/ communication technologies (e.g., internet, computers, smart phones)	.018	.037	7.28	4.27	3.031	.160	18.96	-.037
13.1 The teacher presented tasks and problems that made us apply what we have learned in new ways	.011	.035	7.67	4.18	3.540	.146	24.17	-.131
13.2 The teacher asked questions that made us think about what we have learned	.007	.057	7.77	4.18	3.629	.138	26.31	-.002
13.3 The teacher asked us to explain how we have solved a problem	.037	.058	7.36	4.32	3.120	.160	19.50	-.104
13.4 The teacher gave problems and tasks that make us to think	.012	.067	7.71	4.72	3.050	.150	20.32	-.067
13.5 The teacher helped us to learn from our mistakes	.001	.063	7.82	4.01	3.860	.141	27.30	-.041
13.6 The teacher encouraged us to think for ourselves	.007	.068	7.80	4.69	3.135	.149	21.03	-.079
13.7 The teacher encouraged us to find our own solutions to problems/ assignments	.020	.039	7.47	4.72	2.737	.154	17.77	-.076
*13.8 The teacher allowed us to pursue our own interests	.024	.045	7.28	3.74	3.489	.152	23.01	-.101
*13.9 The teacher explained why what we do in school is important	.016	.049	7.10	3.83	3.288	.153	21.46	.012
*13.10 The teacher talked with us about how we can use the things we learn in school	.019	.042	7.15	3.85	3.339	.163	20.48	-.108
*13.11 The teacher gave us a lot of choices about how to do our schoolwork	.015	.032	6.89	3.59	3.322	.153	21.73	-.004

*13.12 The teacher explained to us why we need to learn the materials presented in this class	.009	.037	7.34	4.01	3.342	.156	21.40	-.105
13.13 The teacher encouraged students to apply their own strategies to solve difficult tasks	.016	.032	7.51	4.45	3.058	.149	20.57	-.012
13.14 The teacher listened to students' ideas	.004	.100	8.05	4.45	3.599	.147	24.46	-.035
13.15 The teacher was always telling us what to do	.008	.068	5.91	5.87	.093	.175	0.54	-.184
13.16 The teacher gave students choices and options	.015	.062	7.49	4.05	3.471	.149	23.32	-.063
*13.17 The teacher listened to how students would like to do things	.008	.081	7.31	3.64	3.679	.153	24.06	-.055
13.18 The teacher tried to understand how students see things before suggesting a new way to do things	.007	.040	7.45	3.60	3.850	.148	25.93	-.105
13.19 The teacher made the subject exciting and interesting	.001	**.167**	7.86	3.06	4.798	.150	31.93	-.166
13.20 Teacher encouraged us to pursue our own interests in relation to class materials and work presented	.022	.057	7.33	3.88	3.456	.156	22.13	-.139
13.21 Teacher encouraged us to figure out how things work by ourselves	.004	.058	7.50	4.63	2.877	.151	19.11	-.069
13.22 Students in my class feel understood by the teacher	.007	.091	7.73	3.15	4.582	.150	30.55	-.167
13.23 The teacher made us feel that we could do well in this class	.007	.105	8.08	4.21	3.865	.144	26.79	-.078
14,1 Overall Teacher Evaluation			7.91	2.82	5.095	.134	37.96	-.198
14.2 Overall Class Evaluation			7.43	3.15	4.286	.147	29.07	-.221
15.1 Difficulty			5.25	5.19	.059	.146	0.40	-.053
15.2 Hours Study			3.14	2.80	.336	.113	2.97	.191
15,3 Intensity			6.99	5.26	1.731	.153	11.30	-.018
15.4 Pace			5.61	4.81	.802	.141	5.69	-.023
15.5 Time			5.23	5.00	.223	.180	1.24	.047
15.6 Workload			5.02	4.98	.040	.169	0.23	.041

Note. Each student made ratings of two teachers, one who was better than average (Good) and one who was poorer than average (Poor). Students indicated items that were not appropriate (Not Appro) and most important (Impt) in describing positive or negative aspects of the class and teacher. The correlation is the correlation between ratings of the good and poor teacher by each student. Item numbers presented here are used in Tables to identify each item.

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Supplemental Table 1
Target and Non-Target Loadings From Exploratory Structural Equation Model (Supplementing Table 3 in Main Text)

SEEQ	Lrn	Ent	Ex	Asg	Grp	Ind	Org	Brd	Wrk	Endeavor	Lrn	Exm	Grp	Ind	Org	Clr	Wrk
Q1P1	.33	.18	.13	.04	-.03	-.26	.15	.26	.24								
Q1P2	.45	.04	.08	.04	.04	-.03	.34	.11	-.01								
Q1P3	.39	.51	.01	.12	-.10	-.12	.08	.18	-.06								
Q1P4	.67	.00	.17	-.01	.09	-.20	.34	.01	-.08								
Q2P1	.10	.76	.08	.00	-.03	.26	-.02	-.19	.02								
Q2P2	.24	.61	-.03	-.09	-.05	.25	.11	-.01	.03								
Q2P3	.18	.53	-.02	-.04	.07	.21	-.01	.06	-.01								
Q2P4	.33	.45	-.07	.02	-.06	.09	.12	.26	-.05								
Q3P1	.18	.04	.43	.12	.01	.08	.08	.08	.01								
Q3P2	.06	-.16	.97	.02	-.05	.28	.04	-.22	.00								
Q3P3	.10	.03	.29	.16	.06	-.08	.43	.02	-.07								
Q4P1	.05	-.15	-.09	1.00	-.02	.11	-.07	.02	.06								
Q4P2	.19	.01	.16	.74	-.03	-.09	-.17	.11	-.05								
Q4P3	.00	-.13	-.07	.80	.04	.21	.01	.09	.03								
Q4P6	-.14	-.05	.26	.65	.02	-.12	.17	.01	-.07								
Q5P1	.04	-.15	-.07	-.11	.70	.32	.18	.32	.03								
Q5P2	.03	.00	.09	.07	.73	.01	-.16	.48	-.08								
Q5P3	-.01	.02	.02	.13	.34	.28	.10	.32	-.01								
Q5P4	-.17	.07	.09	.09	.49	.21	.07	.37	-.07								
Q6P1	-.15	.23	.11	-.13	.32	.64	.01	-.02	.00								
Q6P2	-.16	.14	.15	.05	.22	.60	.04	.06	.05								
Q6P3	.02	.39	-.02	.06	.17	.58	-.11	-.10	.05								
Q6P4	-.24	.24	.09	.22	.06	.56	.08	-.08	.01								
Q7P1	.37	.15	.11	.04	-.04	-.02	.36	.17	-.09								
Q8P1	.07	-.01	.08	.06	.07	.09	.47	.21	.07								
Q7P2	.19	.13	.08	.07	-.15	.04	.56	.12	.00								
Q7P3	.22	.04	.12	-.09	.04	.08	.50	.16	.06								
Q7P4	.16	-.03	.20	-.04	.18	-.17	.18	.19	.20								

Q10P1	.11	.24	-.02	.02	.36	-.02	.07	.37	-.01
Q10P2	.23	-.10	.04	.04	.25	.07	.33	.24	.06
Q10P3	.22	.11	.11	.00	.30	-.09	.06	.44	-.01
Q10P5	.01	.06	-.07	.10	.40	-.14	.22	.43	.11
Q10P4	.18	.09	-.06	.19	.17	.12	.20	.17	.01
DIFF	-.28	-.16	-.10	-.14	-.03	.09	.12	.08	.75
HOURS	.23	.01	-.17	.06	-.01	-.06	-.34	-.14	.72
PACE	.05	-.04	.03	-.11	-.31	-.05	.26	.01	.66
CLASS	.43	.43	-.01	-.01	-.17	.08	.09	.13	.04
TEACH	.32	.44	.01	-.11	-.08	.18	.08	.23	.05

Endeavor	Lrn	Exm	Grp	Ind	Org	Clr	Wrk
Q1P5	.68	-.04	-.05	-.01	.32	.12	-.01
Q1P6	.57	.09	.11	-.03	.34	-.11	.03
Q1P7	.82	.08	.10	-.26	.25	-.03	.02
Q3P4	-.01	.84	-.04	-.05	.21	-.07	.01
Q3P5	.04	.87	.00	.10	-.15	.04	.00
Q3P6	.06	.92	-.04	.10	-.16	.04	-.03
Q5P5	.08	-.08	.81	.17	-.02	-.07	-.04
Q5P6	.11	-.01	.90	-.05	-.18	.10	.00
Q5P7	-.10	-.01	.76	.12	.26	-.13	-.03
Q6P5	-.09	.17	.18	.59	.12	.01	.02
Q6P6	-.12	.04	.18	.63	.13	.07	.03
Q6P7	-.11	-.03	-.05	.93	.20	.00	.03
Q7P5	.49	.01	-.09	.20	.45	-.04	.00
Q7P6	.30	-.03	.07	.11	.36	.17	.01
Q7P7	.13	-.04	.13	.14	.26	.28	.04
Q8P2	-.10	.03	.05	-.17	.13	.94	-.01
Q8P3	.14	-.04	-.10	.28	.06	.61	.03
Q8P4	-.10	.04	-.02	-.05	.18	.85	.01
INTENS	.07	-.04	-.16	.20	.10	.10	.67
TIME	-.06	.01	.04	-.06	-.07	-.10	.89
WORK -	-0.02	-.04	.01	-.12	-.07	-.04	.90

Note. Full set of target and non-target loadings for the Set ESEM factor analysis of the combined set of items representing the SEEQ and Endeavor instruments (supplementing Table 3 in the main text where only the target loadings are presented; in main test see Table 2 for goodness of fit; Table 4 for factor correlations; and Appendix 1 for wording of the items). In the set-ESEM, items from each instrument were allowed to cross-load on other factors from the same instrument but cross-loadings from items from one instrument to the other instrument were constrained to be zero

Supplemental Table 2

MTMM Correlation Matrix -- CFA (upper diagonal) ESEM (Lower Diagonal)

	SLRN	SEXM	SGRP	SIND	SORG	SWRK	SBRD	SENT	SASG	ELRN	EEXM	EGRP	EIND	ECLR	EWRK	EORG
SEEQ (S) Factors																
SLRN	***1.0***	***.94***	.94	.91	.97	.22	.97	.98	.92	.99	.84	.92	.93	.91	.16	.97
SEXM	.57	***1.0***	.93	.92	.94	.20	.94	.92	.91	.95	.96	.91	.92	.91	.14	.95
SGRP	.52	.56	***1.0***	.97	.95	.19	.98	.95	.90	.92	.84	1.02	.98	.89	.12	.95
SIND	.81	.56	.35	***1.0***	.93	.20	.94	.95	.88	.87	.84	.94	.99	.88	.15	.90
SORG	.65	.60	.71	.65	***1.0***	.23	.97	.97	.92	.94	.86	.93	.94	.96	.17	.97
SWRK	.32	.53	.42	.31	.48	***1.0***	.25	.23	.29	.22	.17	.15	.22	.27	.96	.23
SBRD	.52	.63	.06	.68	.41	.39	***1.0***	.96	.91	.95	.84	.97	.95	.91	.18	.97
SENT	.55	.75	.75	.52	.78	.58	.49	***1.0***	.88	.94	.81	.92	.95	.91	.14	.97
SASG	.76	.74	.69	.69	.85	.58	.53	.78	***1.0***	.88	.85	.87	.89	.88	.21	.89
Endeavor (E) Factors																
ELRN	.94	.68	.65	.78	.85	.48	.54	.72	.84	***1.0***	.82	.90	.89	.89	.16	.98
EEXM	.70	.91	.59	.71	.71	.49	.57	.69	.83	.78	***1.0***	.82	.85	.81	.10	.82
EGRP	.78	.76	.86	.76	.84	.51	.56	.82	.86	.87	.82	***1.0***	.95	.86	.11	.93
EIND	.80	.66	.62	.92	.86	.46	.64	.75	.82	.88	.78	.90	***1.0***	.89	.16	.93
ECLR	.69	.71	.63	.70	.93	.53	.53	.81	.88	.83	.78	.83	.83	***1.0***	.19	.91
EWRK	.19	.30	.28	.13	.30	.86	.16	.34	.37	.27	.26	.28	.25	.32	***1.0***	.17
EORG	.52	.89	.60	.42	.54	.50	.69	.86	.73	.65	.68	.76	.60	.70	.30	***1.0***

Note. Multitrait-multimethod matrix of correlations between matching SEEQ and Endeavor factors (shown in rectangles outlined in bold) based on ESEM (below the main diagonal) and CFA (above the main diagonal). Convergent validities (highlighted in the diagonal of each box) are all statistically significant and consistently higher than correlations involving non-matching factors (heterotrait-heteromethod and heterotrait-monomethod correlations). See Table x for goodness of fit and Table xx for factor loadings.

Supplemental Table 3

Summary of Multitrait-Multimethod (MTMM) Analyses: Convergent and Discriminant Validity to Responses to SEEQ and Endeavor instruments.

Comparison of results based on confirmatory factor analysis (CFA) and ESEM

Type of Coefficient	Model	N of corrs	Median	Mean	SE of Mean	Min	Max
Convergent Validity	CFA	6	.98	.98	.01	.96	1.02
	ESEM	6	.92	.90	.01	.86	.94
HTMM Heterotrait Monomethod	CFA	30	.88	.66	.06	.10	.97
	ESEM	30	.59	.59	.04	.25	.90
HTHM Heterotrait Heteromethod	.CFA	30	.88	.66	.06	.12	.98
	ESEM	30	.67	.61	.04	.13	.86
Other	CFA	54	.92	.82	.04	.14	.98
	ESEM	54	.67	.63	.02	.06	.89
Total	CFA	120	.91	.75	.03	.10	1.02
	ESEM	120	.67	.63	.02	.06	.94

Note. Summary of correlations based on the MTMM matrix (Table 4). No.of correlations is the number of correlations falling into each category. Other correlations refer to those involving the three SEEQ factors that did not match any of the Endeavor factors or the one Endeavor factor that did not match any SEEQ factors. Note that the CFA solution is technically improper as one of the estimated correlations exceeded 1.0.

Supplemental Table 3
Scalar Invariant Factor Solution Over Younger (Years 7 & 8) and Older (Years 9, 10 & 11) Students

Factor Loadings (Invariant Over Younger and Older Students)

	Lrn	Ent	Exm	Asg	Grp	Ind	Org	Pln	Brd	Wrk	Rel	Cho	Cog	Mang	Tech
Learning															
Q1.2	.62	-.05	-.08	.08	-.10	.25	.02	.11	.14	-.04					
Q1.4	.86	-.09	-.05	.02	-.01	.12	.01	.10	.03	-.10					
CLAS	.22	.34	.01	.11	-.08	.01	-.02	.30	-.02	.03					
Q1.7	.62	-.03	.11	-.04	.09	-.12	.05	.33	-.08	.02					
Enthusiasm															
Q2.1	-.09	.96	.08	.01	.06	-.19	.01	-.05	.17	-.04					
Q2.2	.14	.66	-.09	-.04	-.07	.13	-.01	.16	.10	-.01					
TEACH	.04	.36	.01	-.07	-.07	.17	-.04	.46	.06	.07					
Q2.5	.09	.93	-.06	.01	.03	.14	.07	-.15	-.16	.03					
Exams/Grading															
Q3.1	-.06	.03	.73	.14	-.01	.01	-.04	.23	-.09	.00					
Q3.2	.12	-.02	.65	.11	.24	.24	.05	-.08	-.41	.01					
Q3.7	-.08	-.06	.90	.05	-.27	.12	-.06	.15	.24	-.05					
Homework/Assignments															
Q4.1	.09	-.09	.02	.83	-.01	.00	.11	-.13	.09	.04					
Q4.2	.08	.01	.23	.67	.19	-.27	-.01	.07	-.10	.00					
Q4.3	-.02	-.02	.04	.87	-.02	.01	.00	-.10	.19	.01					
Group Interaction															
Q5.2	.07	-.01	-.03	.04	.76	.00	-.01	.00	.18	-.05					
Q13.14	-.07	.03	.15	.01	.62	.23	-.05	-.02	.09	.01					
Q5.7	-.10	-.07	-.15	.13	.80	.09	-.05	.07	.30	-.03					
Individual Interaction															
Q6.2	-.05	.16	.17	-.05	.12	.75	.09	-.13	-.07	.07					
Q6.5	.04	.02	.11	-.10	.16	.72	.08	-.08	.06	.05					
Q13.23	.29	.09	.09	-.06	.06	.49	-.04	.05	.04	-.03					
Organization/Clarity															
Q8.2	-.03	-.07	.07	.02	-.01	-.03	.91	.04	.00	-.03					
Q8.3	.09	.11	-.15	.12	-.12	.14	.51	.15	.09	.03					
Q8.4	-.03	-.03	.01	-.04	.00	-.01	.90	.09	.00	.01					
Planning															
Q7.5	.25	.14	.07	-.05	.14	-.14	.00	.53	.00	.03					
Q7.6	.16	.05	.20	-.11	.00	-.09	.05	.37	.34	-.03					
Q7.7	.03	-.01	.01	-.10	-.01	.00	.13	.34	.52	-.01					
Q7.1	.30	.19	-.02	.11	-.11	.04	.07	.35	.07	-.06					
Breadth of Coverage															
Q10.1	-.07	.09	.01	-.09	.19	.05	-.16	.27	.69	-.03					
Q13.4	.14	-.02	-.05	-.03	.09	-.12	.15	.23	.42	.14					
Q10.4	.04	.08	-.15	.30	.02	.08	-.05	.19	.49	-.05					
Q10.5	-.09	-.03	-.08	-.03	.18	-.04	.12	.24	.62	.05					
Workload/Difficulty															
DIFFI	-.39	.00	-.08	.02	-.02	.09	.13	-.04	-.01	.62					
INTENs	.07	.06	-.06	-.04	-.10	-.01	.04	.14	-.06	.75					
TIME	.02	-.11	.02	-.02	.00	.01	-.17	-.19	.03	.90					
WORK	.05	-.04	-.06	-.03	-.08	-.12	-.11	-.08	.01	.90					
Relevance															

Q13.9	.92	-.19	.19	-.02	-.05
Q13.10	.85	.07	-.04	.07	.07
Q13.12	.88	.18	-.07	.07	-.03
Choice					
Q13.8	.13	.65	.10	.07	.10
Q13.11	.09	.77	-.02	.16	.13
Q13.17	-.08	1.03	.13	.13	-.09
Cognitive Activation					
Q13.7	-.07	-.06	1.07	.01	-.02
Q13.13	.05	.10	.86	.06	-.03
Q13.21	.12	.11	.51	.04	.20
Classroom Management					
Q11.3	.12	.31	.09	-.44	.09
Q11.5	.06	-.05	-.01	.66	-.06
Q11.6	-.07	-.12	.02	.50	.08
Q11.8	-.05	.20	-.03	.72	-.06
Technology					
Q12.2	.05	.02	.09	.03	.79
Q12.4	.00	-.02	.00	.02	.98
Q12.5	-.06	.08	.08	.04	.86

Supplemental Table 3 (continued)

	Factor Covariances(Younger Group)														
	Lrn	Ent	Exm	Asg	Grp	Ind	Org	Pln	Brd	Wrk	Rel	Cho	Cog	Mang	Tech
Lrn	1.00														
Ent	.84	1.00													
Exm	.86	.84	1.00												
Asg	.76	.79	.76	1.00											
Grp	.78	.82	.80	.72	1.00										
Ind	.72	.83	.70	.86	.71	1.00									
Org	.86	.88	.88	.80	.80	.76	1.00								
Pln	.68	.81	.75	.84	.82	.89	.78	1.00							
Brd	.86	.88	.89	.76	.78	.74	.89	.73	1.00						
Wrk	.57	.46	.52	.43	.47	.38	.49	.40	.60	1.00					
Impt	.82	.85	.80	.86	.76	.85	.81	.83	.86	.48	1.00				
Choice	.76	.92	.83	.84	.81	.90	.86	.92	.89	.47	.89	1.00			
Reflect	.80	.80	.80	.79	.86	.76	.78	.78	.80	.51	.83	.82	1.00		
Mang	-.41	-.47	-.43	-.40	-.36	-.30	-.50	-.46	-.40	-.39	-.39	-.47	-.35	1.00	
Tech	.75	.80	.74	.86	.73	.82	.82	.79	.84	.44	.83	.87	.77	-.33	1.00
	Factor Covariances(Older Group)														
	Lrn	Ent	Exm	Asg	Grp	Ind	Org	Pln	Brd	Wrk	Rel	Cho	Cog	Mang	Tech
Lrn	1.05														
Ent	.87	1.02													
Exm	.78	.79	.90												
Asg	.86	.81	.75	1.00											
Grp	.72	.72	.69	.65	.84										
Ind	.72	.75	.68	.77	.64	.81									
Org	.76	.81	.75	.76	.63	.67	.99								
Pln	.88	.83	.81	.90	.76	.82	.79	1.21							
Brd	.81	.78	.67	.71	.62	.62	.74	.65	.84						
Wrk	.44	.51	.47	.47	.32	.29	.53	.35	.50	1.11					
Impt	.81	.78	.68	.78	.62	.68	.70	.84	.70	.38	.87				
Choice	.79	.83	.73	.79	.68	.76	.73	.87	.75	.34	.75	.89			
Reflect	.69	.65	.62	.62	.66	.57	.58	.70	.60	.36	.64	.66	.73		
Mang	-.46	-.48	-.38	-.50	-.38	-.40	-.52	-.74	-.30	-.25	-.44	-.47	-.36	1.17	
Tech	.63	.59	.52	.62	.51	.58	.55	.64	.63	.25	.63	.67	.56	-.29	.88
	Factor Mean Differences(Older-Younger Group)														
MeanDiff	-.05	.07	.10	-.04	.15	.07	-.03	-.11	.18	.29	.03	.08	.12	-.02	.03
SEDiff	.13	.05	.10	.09	.07	.07	.07	.22	.13	.07	.05	.05	.05	.08	.06

Note. Scalar invariant ESEM factor analysis of the Final SEEQ-S instrument (Model xx in Table 1; See Appendix 1 for the wording of selected items). Students were divided into year groups (Years 7 and 8, lower secondary school; Years 9, 10 and 11, upper secondary school). Tests of invariance provided good support for configural, metric, and scalar invariance (see Table 4 in main text). Shown here are factor loadings for the scalar invariant solution, latent factor covariances, and latent mean differences between the two groups.

Supplemental Table 4

MTMM Correlation Matrix -- CFA (upper diagonal) ESEM (Lower Diagonal)

	SLRN	SEXM	SGRP	SIND	SORG	SWRK	SBRD	SENT	SASG	ELRN	EEXM	EGRP	EIND	ECLR	EWRK	EORG
SEEQ (S) Factors																
SLRN	*1.0*	**.94**	.94	.91	.97	.22	.97	.98	.92	.99	.84	.92	.93	.91	.16	.97
SEXM	.57	***1.0***	.93	.92	.94	.20	.94	.92	.91	.95	.96	.91	.92	.91	.14	.95
SGRP	.52	.56	***1.0***	.97	.95	.19	.98	.95	.90	.92	.84	1.02	.98	.89	.12	.95
SIND	.81	.56	.35	***1.0***	.93	.20	.94	.95	.88	.87	.84	.94	.99	.88	.15	.90
SORG	.65	.60	.71	.65	***1.0***	.23	.97	.97	.92	.94	.86	.93	.94	.96	.17	.97
SWRK	.32	.53	.42	.31	.48	***1.0***	.25	.23	.29	.22	.17	.15	.22	.27	.96	.23
SBRD	.52	.63	.06	.68	.41	.39	***1.0***	.96	.91	.95	.84	.97	.95	.91	.18	.97
SENT	.55	.75	.75	.52	.78	.58	.49	***1.0***	.88	.94	.81	.92	.95	.91	.14	.97
SASG	.76	.74	.69	.69	.85	.58	.53	.78	***1.0***	.88	.85	.87	.89	.88	.21	.89
Endeavor (E) Factors																
ELRN	.94	.68	.65	.78	.85	.48	.54	.72	.84	***1.0***	.82	.90	.89	.89	.16	.98
EEXM	.70	.91	.59	.71	.71	.49	.57	.69	.83	.78	***1.0***	.82	.85	.81	.10	.82
EGRP	.78	.76	.86	.76	.84	.51	.56	.82	.86	.87	.82	***1.0***	.95	.86	.11	.93
EIND	.80	.66	.62	.92	.86	.46	.64	.75	.82	.88	.78	.90	***1.0***	.89	.16	.93
ECLR	.69	.71	.63	.70	.93	.53	.53	.81	.88	.83	.78	.83	.83	***1.0***	.19	.91
EWRK	.19	.30	.28	.13	.30	.86	.16	.34	.37	.27	.26	.28	.25	.32	***1.0***	.17
EORG	.52	.89	.60	.42	.54	.50	.69	.86	.73	.65	.68	.76	.60	.70	.30	***1.0***

Note. Multitrait-multimethod matrix of correlations between matching SEEQ and Endeavor factors (shown in rectangles outlined in bold) based on ESEM (below the main diagonal) and CFA (above the main diagonal). Convergent validities (highlighted in the diagonal of each box) are all statistically significant and consistently higher than correlations involving non-matching factors (heterotrait-heteromethod and heterotrait-monomethod correlations). See Table x for goodness of fit and Table xx for factor loadings.

Supplemental Table 5
Summary of Multitrait-Multimethod (MTMM) Analyses: Convergent and Discriminant Validity to Responses to SEEQ and Endeavor instruments

Type of Coefficient	Model	N of corrs	Median	Mean	Mean	Min	Max
Convergent Validity	CFA	6	.98	.98	.01	.96	1.02
	ESEM	6	.92	.90	.01	.86	.94
HTMM Heterotrait Monomethod	CFA	30	.88	.66	.06	.10	.97
	ESEM	30	.59	.59	.04	.25	.90
HTHM Heterotrait Heteromethod	.CFA	30	.88	.66	.06	.12	.98
	ESEM	30	.67	.61	.04	.13	.86
Other	CFA	54	.92	.82	.04	.14	.98
	ESEM	54	.67	.63	.02	.06	.89
Total	CFA	120	.91	.75	.03	.10	1.02
	ESEM	120	.67	.63	.02	.06	.94

Note. Summaries are based on correlations in the MTMM matrix (Table 3).

Section 1
An extended discussion of research on SETs in University Settings (U-SETs)

Here we offer an extended discussion of research on the SETs in University Settings (U-SETs) that has been summarized in printed version of the article.

SETs in University Settings (U-SETs)

In their systematic review of the history of U-SETs, Spooren, Vandermoere, Vanderstraeten, and Pepermans (2017) emphasized that U-SETs are now used in "almost every institution of higher education throughout the world" (p. 130) and are the basis of literally many thousands of peer-reviewed journal articles covering in detail topics such as their usefulness, validity, and dimensionality. They further noted that even though historical knowledge is based on the classic studies dating back to the 1960s-1980s that continue to be widely cited, studies since 2000 suggests ongoing interest in U-SET research. Hence, it is not surprising that substantive and methodological studies in this area have resulted in a huge research literature, making it one of the most widely studied topics in education and educational psychology journals. This research shows that U-SET ratings, when based on appropriate instruments, are reliable, valid, relatively unbiased, and useful in providing diagnostic strengths and weaknesses that can lead to improved teaching effectiveness when coupled with a consultative feedback intervention (Author, 1987; 2007; Author & Dunkin, 1992; also see Benton & Cashin, 2014; Cashin, 1988; Benton & Ryalls, 2016; Spooren, Brockx & Mortelmans, 2013; Spooren et al., 2017; Wachtel, 1998). In some of the most comprehensive reviews of this research, Author (1987; 2007; Author & Dunkin, 1992) concluded that U-SETs are one of the most highly researched personnel evaluation systems, and one of the best in terms of validity, reliability, and usefulness. He argued that no indicator of teaching effectiveness – test scores, classroom observations, administrator reports, qualifications – reflects university teaching effectiveness as well as U-SETs.

Dimensionality

Effective teaching is a hypothetical construct for which there is no adequate single indicator. Hence, the validity of U-SETs or of any other indicator of effective teaching must be demonstrated through a construct validation approach. Extensive reviews of this research in higher education (e.g., Abrami, d'Apollonia, & Cohen, 1990; Cashin, 1988; Cohen, 1980; Feldman, 1989a, 1989b, 1997, 1998; 2007; Author, 1982, 1984, 1987, 2007b; Author & Dunkin, 1997; Author & Roche, 1997; McKeachie, 1979, 1997; Spooren, et al. 2017; Wachtel, 1998) have consistently shown that, with careful attention to measurement and theoretical issues, U-SETs are: (i) multidimensional; reliable and stable; (ii) primarily a function of the instructor who teaches a class rather than the class that is taught; (iii) relatively valid against a variety of indicators of effective teaching; (iv) relatively unaffected by a variety of variables hypothesised as potential biases (e.g., expected class grades, class size, workload, and prior subject interest); and (v) demonstrably useful in improving teaching effectiveness when coupled with concrete enhancement strategies in specific areas of teaching effectiveness. Similarly, in an integrative synthesis of meta-analyses based on U-SET research, Wright and Jenkins-Guarnieri (2012) concluded that U-SETs are reliable, valid, relatively free from bias, and most effective in improving teaching effectiveness when implemented in combination with consultative strategies.

Researchers and practitioners (e.g., Abrami & d'Apollonia, 1990; Benton & Cashin, 2014; Cashin, 1988; Feldman, 1997; Author, 2007b; Author & Roche, 1993; Renaud & Murray, 2005; Richardson, 2005) agree that teaching is a complex, multidimensional activity comprising multiple interrelated components (e.g., clarity, interaction, organization, enthusiasm, feedback). Hence, U-SETs, like the teaching they are intended to represent, should also be multidimensional. This is especially important given the fact that U-SETs are generally designed as formative/diagnostic feedback tools intended to contribute to the improvement of teaching. As such, they should reflect teaching multidimensionality and target specific aspects needing improvement (e.g., a teacher can be organized but lacking enthusiasm). However, poorly worded, double-barrelled, or inappropriate items do not provide useful information because they will be difficult to interpret, whilst scores averaged across an ill-defined assortment of items will offer no basis for knowing what is being measured and for targeting specific areas of improvement. Indeed, valid measurement requires a continual interplay between theory, research and practice and a careful determination of the components that are to be measured. From this perspective, a critical starting point for U-SET research was factor analysis studies demonstrating that U-SETs instruments had a well-defined, multidimensional factor structure in support of a priori factors that the U-SET instrument was designed to measure.

Student Evaluation of Educational Quality (SEEQ) Instrument.

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Although there are many U-SET instruments, the Student Evaluation of Educational Quality (SEEQ) instrument, that is the basis of the present investigation, is broadly acknowledged to be the most widely studied instruments in the world. Thus, an overarching review of student rating instruments used to collect feedback about effectiveness in higher education, Richardson (2005, p. 404) concluded:

> *It is clearly necessary that such a questionnaire should be motivated by research evidence about teaching, learning and assessment in higher education and that it should be assessed as a research tool. The only existing instruments that satisfy these requirements are the SEEQ [Student Evaluation of Educational Quality; Author, 1984, 1987] (for evaluating individual teachers and course units).*

Similarly, in their integrative review of U-SET research, Wright and Jenkins-Guarnieri (2012) concluded that: One SET measure in particular has benefited from ample, sound research and appears to be a reliable and valid, multidimensional measure of teaching effectiveness: the Students' Evaluation of Educational Quality (SEEQ; Author 1982). More generally, Boysen (2016) argues effective use of U-SETs requires the use of standardized, multidimensional instruments the established reliability and validity such as SEEQ and a relatively few other U-SET instruments that have a strong research basis,

Particularly strong support for the multidimensionality of U-SETs comes from SEEQ research (Author, 1982, b; 1987; 2007b; Author & Dunkin, 1997; Author & Hocevar, 1991; Richardson, 2005). To develop SEEQ, a large item pool was first obtained from a literature review, from U-SET instruments already used, and from interviews with faculty members and students about what they considered to be effective teaching. Students and teachers were asked to rate the importance of the proposed items; teachers were asked to judge the potential usefulness of the items as a basis for feedback, and students also provided open-ended comments that were examined to determine if important aspects had been excluded. These criteria, along with psychometric properties, were used to select items and revise subsequent versions, thus supporting the content validity of SEEQ responses. Author and Dunkin (1992, 1997; Author & Roche, 1993) also demonstrated that the content of the SEEQ factors was consistent with general principles of teaching and learning, with a particular emphasis on theory and research in adult education that is most relevant to higher education settings. As noted by Richardson (2005), Wright and Jenkins-Guarnieri (2012), and Boysen (2016), the SEEQ instrument continues to be widely used in published research which provides a strong empirical, conceptual, and theoretical basis for the SEEQ factors.

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Author and Dunkin (1997) noted three overlapping approaches to the identification, construction, and evaluation of multiple dimensions in U-SET instruments that are the basis of SEEQ: (1) empirical approaches such as factor analysis and multitrait-multimethod (MTMM) analysis; (2) logical analyses of the content of effective teaching and the purposes the ratings are intended to serve, supplemented by reviews of previous research and feedback from students and instructors (see Feldman, 1976); and (3) a theory of teaching and learning. In practice, most instruments are based on either of the first two approaches—particularly the second. The U-SET literature contains examples of instruments that have a well-defined factor structure, such as (Author, 1987; Centra, 1993; Jackson et al., 1999; Author & Dunkin, 1997; Richardson, 2005). Factor analyses have identified the factors that each of these instruments is intended to measure, demonstrating that U-SETs do measure distinct components of teaching effectiveness. The systematic approach used in the development of these instruments, and the similarity of the factors that they measure, supports their construct validity.

Factor analytic support for the SEEQ scales is particularly strong. The factor structure of SEEQ has been replicated in many published studies, but the most compelling support is provided by Author and Hocevar (1991). Starting with an archive of 50,000 sets of class-average ratings (reflecting responses to 1 million SEEQ surveys), they defined 21 groups of classes that differed in terms of course level (undergraduate/graduate), instructor rank (teaching assistant/regular faculty), and academic discipline. The nine a priori SEEQ factors were identified in each of 21 separate factor analyses. Whereas most SEEQ research has focused on student responses to the instrument, the same nine factors were identified in several large-scale studies of teacher self-evaluations of their own teaching using the SEEQ instrument (Author, Overall, & Kesler, 1979; Author, 1983; also see Author, 1987, p. 295). In evolving best practice of factor analysis methodology, Author, Morin, Parker, and Kaur (2014) demonstrated the application of exploratory structural equation modeling (ESEM) based on a large normative archive of SEEQ ratings, performing better than conventional confirmatory factor analysis (CFA).

The focus of U-SET research on factor structure is important from a psychometric perspective, but Author (2007; Author & Roche, 1994) argued that the identification of distinguishable factors is critical in terms of providing diagnostic feedback that is useful for improving teaching effectiveness that has been an important emphasis in U-SET research. Indeed, receiving feedback from U-SETs is nearly universal in universities world-wide and largely viewed positively by university teachers as having a positive impact on

improving teaching effectiveness (Boysen, 2016; Flodén, 2017; Mart, 2017; Spooren, Brockx & Mortelmans, 2013).

Focus on Improving Teaching Effectiveness.

Although relative usefulness of a single global score compared to a multidimensional profile of specific components and overall rating items for use in personnel decisions is the source of much debate in higher education research (e.g., Abrami & d'Appollona, 1990; Boysen, 2016; Author, 1987; 2007), there is broad agreement that the multidimensional perspective is more useful for purposes of feedback aimed at improving teacher effectiveness and research on teaching. In support of this rationale, Author (2007; Author & Roche, 1993) developed and tested a prototype feedback/consultation based on the SEEQ instrument. In addition to random assignment, key features of this intervention research involved teachers evaluating themselves and being evaluated by their students in two different classes taught in consecutive semesters. Feedback teachers selected one or two target SEEQ factors (e.g., Learning/value, Enthusiasm, Organisation, Breadth of Coverage, Group Interaction) that were the focus of their intervention. Teachers typically selected SEEQ factors for which they were relatively weak (based on prior U-SETs and their own teacher self-evaluations), but that were seen as important to improve by the teacher. Feedback teachers were given a book of practical strategies to improve teaching effectiveness for each SEEQ factor that they had selected and, in consultation with an external consultant, chose a few of the more relevant strategies and decided how they would be implemented as their intervention.

The SEEQ feedback/consultation provided an effective means of improving university teaching. Feedback Teachers were rated .5 SD higher than randomly assigned control teachers on overall rating items. Importantly, the differences were much larger for targeted SEEQ factors (chosen by teacher as the focus of their intervention) and much smaller for non-target SEEQ factors. These factors targeted by each teacher went from being weakest SEEQ factors (which was why they were chosen) to being among the strongest as a consequence of the intervention. Also, the effects were stronger for the initially less effective teachers. The differentiation among the SEEQ factors and corresponding strategy books developed for each SEEQ factor were important components of this intervention. These results support the construct validity of the intervention and the multidimensional perspective upon which it was based. However, the results also demonstrate that the SEEQ factors are not only distinguishable in actual settings, but are also amenable to systematic change based on intervention. We argue that this focus on a well-defined factor structure that has been so important in SEEQ research and U-SET research more generally should also be a critical starting point for S-SET research as well.

Supplemental Section 2

Extended Discussion of the use of the applicability paradigm to evaluate the appropriateness student evaluation instruments in diverse Tertiary Settings

Applicability Paradigm

Early U-SET research and instruments were largely based on North American studies. Author (1981; 1984; 2007) argued that it should not automatically be assumed that these instruments were equally appropriate for use in different countries around the world and other tertiary settings. Thus, he developed what became known as the "applicability paradigm" to evaluate this assumption. In a series of four articles implementing the applicability paradigm (see review by Author, 1986), university students were asked to select a "good" and a "poor" instructor from their previous experience and to evaluate these instructors on a survey that contained items from both the SEEQ (Author, 1987, 2007; Author et al., 2011) and Endeavor (Frey, 1973, 1978; Frey, Leonard, & Beatty, 1975) instruments. The four studies were conducted with Sydney University undergraduate students, Australian students in Technical and Further Education (TAFE) schools; Spanish students from the University of Navarra; and students from the Papua New Guinea University of Technology. In a review of the four studies, Author (1986) reported that (a) all items were judged to be appropriate by a large majority of the students; (b) all items were selected by some students as being most important; (c) there was a surprising consistency in the items judged to be less appropriate and most important; (d) all but the Workload/Difficulty items clearly differentiated between good and poor instructors; (e) factor analyses generally replicated the factors that each instrument was designed to measure; and (f) multitrait-multimethod (MTMM) analyses demonstrated strong support for both the convergent and divergent validity of SEEQ and Endeavor responses.

Endeavor Instrument: Comparison of Factors Measured by SEEQ and Endeavor instruments.

f particular relevance to the present investigation were the MTMM analyses of relations between the SEEQ and Endeavor factors. Indeed, particularly at the time the applicability paradigm studies were devised, the research on the Endeavor instrument – along with the SEEQ instrument -- was highly cited and among the best in terms of demonstrating reliability, validity, lack of bias, and a clearly defined factor structure (Frey, 1973, 1978; 1979; Frey, Leonard, & Beatty, 1975; also see review by Author, 1984). Indeed, Frey and colleagues were among the earliest proponents of the need to consider multiple dimensions of teaching effectiveness, showing that the Endeavor factors were differentially related to different criteria—particularly student learning. Although SEEQ and Endeavor instruments were independently designed and do not even measure the same number of components of effective teaching, a content analysis of the items and factors (Author, 1981, 1986) suggest that there is considerable overlap. For these reasons, the Endeavor instrument was chosen to validate SEEQ responses by means of a MTMM analysis.

There appears to be a one-to-one correspondence between the first five SEEQ factors (Group Interaction; Learning/Value; Workload/Difficulty; Exams/Grading; Individual Rapport) and the five Endeavor factors (Class Discussion, Student Accomplishments; Workload; Grading/Exams; Personal Attention) but the Organization/Clarity factor from SEEQ seems to combine particularly the Presentation Clarity but also the Planning factors from Endeavor. The remaining three SEEQ factors—Instructor Enthusiasm, Breadth of Coverage, and Assignments/Readings—do not appear to parallel any factors from Endeavor. Also, the SEEQ instrument has two overall rating items (Overall Class, most related to the Learning/Value factor and Overall Teacher, most related to the Instructor Enthusiasm factor), whereas the Endeavor instrument has none.

The applicability paradigm: Summary and rationale.

Author (1986; 2007) argued that the correlations between the nine SEEQ and seven Endeavor factors is like a MTMM matrix (Campbell & Fiske, 1959): the multiple traits are the 16 factors; convergent validities are correlations between matching SEEQ and Endeavor factors; discriminant validity refers to the distinctiveness of the different factors based on correlations between non-matching SEEQ and Endeavor factors. In a summary of the MTMM analyses across with four studies, Author (1986) concluded that factors from the two instruments hypothesized to measure similar dimensions of effective teaching were substantially correlated, whereas correlations between nonmatching factors were substantially smaller. Hence, the factor analyses and MTMM analyses demonstrate that factors based on students' responses in very different settings are generalizable and that students differentiate among dimensions of effective teaching in a similar manner when responding to SEEQ and Endeavor. More broadly, across the four studies, the findings support the generality of the evaluation factors across independently constructed instruments and quite different educational settings.

The "applicability paradigm" based on North American U-SET instruments has now been used in studies conducted (see reviews by Author & Roche, 1992; 1994; Watkins, 1994) in different Australian and New Zealand universities, in a cross-section of Australian Technical and Further Education institutions, and in universities from a variety of different countries (e.g., Spain, Papua New Guinea, India, Nepal, Nigeria, the Philippines, and Hong Kong). Watkins (1994) critically evaluated this applicability paradigm research in relation to criteria derived from cross-cultural psychology. He adopted an "etic" approach to cross-cultural comparisons that seeks to evaluate what are hypothesized to be universal constructs based on the SEEQ factors. Based on his evaluation of the applicability paradigm research, Watkins (1994, p. 262) concluded, "the results are certainly generally encouraging regarding the range of university settings for which the questionnaires and the underlying model of teaching effectiveness investigated here may be appropriate." Although the applicability paradigm has been used to test the applicability of U-SET instruments in different tertiary settings, in the present investigation we propose to extend its use to test the applicability of U-SET instruments to secondary school settings.

The rationale of the applicability paradigm is to provide an easy, cost-effective means to evaluate the applicability of the SEEQ instrument in a new setting. Because of the "unit of analysis" problem, it is typically inappropriate to do factor analyses based on responses by individual students. However, the costs and logistics of collecting data for a sufficiently large number of intact classes (many 100s of classes and 10 of thousands classes) to warrant factor analysis at the class-average level can be prohibitive, particularly in the formative stages of evaluation of an instrument in a new setting. The applicability paradigm finesses this issue by seeking to obtain responses from a large number of students such that each student is evaluating a different class/teacher combination. To the extent that each class/student combination is based on responses by a single student, it is appropriate to do analyses at the level of the individual student. Although there are clearly limitations to this approach (e.g., ascertaining the agreement among students within the same class) that is designed to be a starting point for a more extensive research program, research at the university level has shown it to be highly useful in relation to its intended purposes based on research at the university level. The present investigation is apparently the first application of the applicability paradigm to the secondary school setting, but it seems ideally suited to test the appropriateness of U-SET instruments in secondary-school settings – the overarching purpose of the present investigation.

Supplemental Section 3
Extended Discussion of the Rationale For the Inclusion of Additional Factors of Teaching Effectiveness

Additional scales added to traditional SEEQ

For adapting the established SEEQ instrument to fit the secondary school environment is what not only necessary to modify some of the items wording, but also to update and extend the content of SEEQ. In discussion with the school's principals and after a screening of recent literature we chose to include items on ICT/technology use in the classroom, classroom management, and autonomy support in the classroom (self-determination theory). In the following paragraph we will provide a brief rational for the inclusion of each.

Technology (ICT) in the classroom. In line with the world-wide aim of educational systems to develop the digital competency of students (Gil-Flores, Rodríguez-Santero, & Torres-Gordillo, 2017), thereby preparing them to function in a 21 century workplace (Koh, Chai, & Lim, 2017), the usage of technology for teaching and learning is steadily increasing (Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). The degree, however, to which this usage can be called "integrated" into the curricula and lessons is still varied and often time limited (e.g., Koh, Chai, Benjamin, & Hong, 2015; Tondeur et al., 2017). It seems that teachers are not yet fully prepared to use technology for pedagogical aims, but rather for content transmission (Koh et al., 2015, 2017). Koh et al., 2017 (see also Chuang, Weng, & Huang, 2015) thus, suggest the importance of technological pedagogical content knowledge (TPACK) which uses design thinking for optimally integrating technology into the classroom. Scales, based on this research, mostly assess TPACK or self-efficacy in TPACK as teacher self-reports (e.g., Koh, Chai, & Ching-Chung, 2014; Scherer, Tondeur, & Siddiq, 2017; Tondeur et al., 2015). We are the first to our knowledge to have developed a scale for assessing integrated technology usage in the classroom, based on the principles of the TPACK-21CL Rubric (Koh et al., 2017), via student ratings. This should prove to be a particularly strong approach for assessing the actual teacher behaviour in line with these principles, more so than teachers' knowledge, beliefs, or self-perceived competencies (see main manuscript for a discussion on the strength of student ratings).

Classroom management.

Due to the nature of the university environment, lecture structure, and age of university students, classroom management typically is not considered as relevant in U-SET literature (Author, 2007). In the secondary school environment and therefore research on S-SETs, however, classroom management is a crucial aspect and core dimension of teacher and instructional quality (e.g., Baumert et al., 2010; Pianta & Hamre, 2009). In order to achieve high-quality instruction, it is necessary to minimize classroom disturbances which make a disturbance-free lesson a major goal of classroom management (Evertson & Weinstein, 2006; Lewis, 1999). Indeed, as a result of their meta-analysis, Wang, Haertel and Walberg. (1993) proposed a decrease in discipline problems as important predictor of student learning (see also Voss, Kunter, & Baumert, 2011). In effect, teachers with effective classroom management skills are able to spend more time on instruction, thus leading to enhanced student achievement, as they need less time to take care of discipline problems (for an overview, see Wang et al., 1993) Further, adequate and flexible classroom management strategies enable freedom of teaching with a wide range of teaching styles that are adaptable to intended learning aims and complex learning environments, such as classroom activities and students' characteristics (Emmer & Stough, 2001; Freiberg & Lapointe, 2006).

Autonomy support in the classroom.

"Autonomy support is the instructional effort to provide students with a classroom environment and a teacher-student relationship that can support their students' need for autonomy." (Reeve, 2016, p.130). A rapidly increasing area of research on self-determination theory in the classroom (e.g., Deci & Ryan, 2010; Vansteenkiste et al., 2012; Sierens et al., 2009) shows that a teacher's highly structured, highly autonomy-supportive teaching style is associated with a wide range of positive and educationally-important student outcomes, such as motivation, engagement, more deep-level learning, and well-being (Cheon & Reeve, 2015; Jang, Reeve, & Deci, 2010). This autonomy supportive teaching includes various ways of instructional behavior that all convey a message of support and understanding (see Reeve, 2016 for an overview). In the present research we focus on a) Cognitive Activation (Baumert et al., 2010; OECD, 2013; Pekrun, Goetz & Frenzel, 2005), which integrates challenging tasks, the exploration of concepts, ideas, and prior knowledge and foster students' cognitive engagement. Although this concept has been predominantly developed in studies of mathematics classrooms, it can be successfully applied to other domains (see Fauth et al., 2014 for an overview); b) teacher support of student choice (Choice; Belmont, et al., 1988), and c) teacher support of appropriate relevance (Relevance, Belmont, et al., 1988). From the perspective of SDT, an autonomy supportive teacher promoted student choice, volitional functioning, and a sense of initiative, interest and relevance (Assor, Kaplan & Roth, 2002; Sosic-Vasic et al. 2015).

Supplemental Section 4

School Sample and Participant Details

A total of ten non-selective Australian high schools (2 single-sex male, 2 single-sex female, 6 co-educational) (N=389, F=54%) participated in the SEEQ-S pilot study. Each resided within NSW, QLD, Victoria or WA with nine being Independent and one governed by the Catholic Education system. All students were enrolled in middle high-school (Years 7-8) and senior high-school (Years 9-11) (ages 11-17 years) during 2017. Individual school involvement in the present research was completely voluntary and opting not to participate did not disadvantage schools in any way.

	Total	Participants	Male		Female	
	N	%	*N*	%	*N*	%
Year 7	80	20.6	34	19.1	46	21.8
Year 8	108	27.8	57	32.0	51	24.2
Yeara 9	81	20.8	23	12.9	58	27.5
Year 10	50	12.9	21	11.8	29	13.7
Year 11	70	18.0	43	24.2	27	12.8
Total	389		178	45.8	211	54.2

Materials

- Online questionnaires x2 - Qualtrics (2017) electronic questionnaire development tool
- Student laptops and email accounts with internet connection
- Student instruction/information email containing the questionnaire link
- Hardcopy student instruction/information sheet
- Parent Information and Consent Form
- Principal information/permission to participate form, including consent to pass on deidentified and anonymous student data to the researchers at the IPPE, ACU.

Questionnaire Design

The pilot questionnaires were developed using Qualtrics (2017) electronic survey development tool and consisted of two identical questionnaires. Items were based on the psychometrically validated Student Evaluation of Educational Quality (SEEQ) (Author, 1982, 1984, 2007) and Endeavour instruments (Frey, 1973, 1978; Frey et al., 1975) and other relevant materials, as well feedback from principals and school executives.

All items in each of the two questionnaires, with the exception of demographic items, were initially randomized and placed into blocks of 20-items, which were followed by their corresponding 20 'importance' items (See Appendix 1). Additionally, for each student, items within each block were randomized, resulting in no two students receiving identical questionnaire item ordering. The order in which the two questionnaires were completed by students was controlled for, resulting in 59.3% of students completing the 'effective teacher' questionnaire first and 'less effective teacher' questionnaire second.

Procedure

School principals were individually contact by research staff from Macquarie Marketing Group Education (MMG) and had the final say on whether individual schools would be involved in the research. School executives were briefed on the nature of the study and ensured that all student data, and the teachers in which their responses related to, would remain anonymous at all stages of the research. Fourteen Schools were initially contacted, 10 of which agreed to participate. Principals were asked to randomly select 10 students from each of the five high-school grades, 7 to 11. Parental/guardian permission to participate was sought in accordance with internal school policy using opt-out consent, whereby parents/guardians would specify if they did not wish their child participates. Where required, students with parental/guardian permission were invited to participate based on informed consent. This procedure was completed for all participants prior to the administration of the first questionnaire.

All questionnaires were completed via student laptops/iPads during Term 4 of 2017. Each student completed two identical online questionnaires using the Qualtrics platform, taking place on school grounds during regular school hours. Each testing session commenced with a brief set of instructions on how to access and complete the questionnaire. One set of instructions asked students to complete the questionnaire in relation to an 'effective teacher' and the other a 'less effective teacher'. These instructions were communicated through student emails containing the questionnaire link, or alternatively via an identical script which was read verbatim by teachers, who further provided a URL address code to access the online questionnaire. The latter procedure was requested by some teaching staff in order to streamline the administration process, which took approximately 20-25 minutes duration. Students were asked to complete the questionnaire on their own and to not discuss their responses.