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A scoping review of research instruments for measuring student engagement: In need for convergence

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ABSTRACT

This article reports on how student engagement is measured in research on technology enhanced learning in higher education. For this purpose, a secondary analysis of a previously conducted systematic review on student engagement in higher education was carried out. 246 research instruments were extracted that relate to the cognitive, affective, and behavioral dimensions of student engagement. Although published in peer-reviewed journals, only 57.4% of the studies reveal their instrument or provide information on how they measured student engagement. Only 30.6% of the presented research instruments report reliability scores but most of those instruments rather relate to learning in general than to learning in educational technology contexts. Only four research instruments were used more than one time. These findings demonstrate the need for a convergence of instruments to operationalize student engagement. For further research, it is highly recommended to re-use instruments developed before and rely on scales with proven psychometric quality: A convergence of evaluated instruments is needed for researchers to rely on an established set of scales for the different dimensions of student engagement. To this end, we recommend relying on generic student engagement scales, as many of these reviewed instruments already exist and fulfill the requirements of psychometric criteria.

1. Introduction

Student engagement has gained high attention in educational research (Aparicio et al., 2020). It has proven to be a good predictor for learning outcome, while providing closer insights into the process of learning (Carini et al., 2006; L.-C. Lin et al., 2019; Pike et al., 2011; Pike et al., 2012; F. H. Wang, 2017). Effects of different instructional designs and emerging educational technologies can be evaluated more closely than measures that are related only to learning outcome (Bond & Bedenlier, 2019; Mazer, 2013; Pianta et al., 2012). Additionally, *formative* assessments of student engagement have been demonstrated to improve learning by providing instant feedback in adaptive learning software, whereas *summative* assessments of student engagement can be an important source for the evaluation of courses and courseware (Henrie, Bodily, et al., 2015; Hepplestone et al., 2011). These aspects have made student engagement an important construct valuable to the research community as well as to the educational practice (Aparicio et al., 2020; Reeve, 2012).

Student engagement has been described as an umbrella construct consisting of several dimensions and facets within each dimension (Ben-Eliyahu et al., 2018; Bond & Bedenlier, 2019; Kahu, 2013; Kahu & Nelson, 2018). Most often, student engagement is described to include an affective, cognitive and behavioral dimension (Bond & Bedenlier, 2019; Eccles, 2016; Kahu, 2013). Some authors add further dimensions, such as agentic engagement (Kahu & Nelson, 2018; Reeve, 2012; Reeve & Tseng, 2011) or social engagement (Fredricks et al., 2016). Other authors relate student engagement to concepts such as motivation or metacognition (Kahu, 2013; Reschly & Christenson, 2012), some do not use the concept of student engagement, but refer to one or two facets of the learning process (Antonenko, 2015; Karabulut-Ilgu et al., 2018).

With regard to the operationalization and measurement of student engagement, Fredricks and McColskey (2012) report on different types of research instruments: questionnaires, behavioral analysis, interviews and behavioral observations. In research on education technology, learning with digital technology often generates log data, which have been used for analyzing various facets of student engagement (Henrie et al., 2018; Henrie, Halverson, & Graham, 2015). Cocea and Weibelzahl (2007) describe how log data can be used as indicators for student engagement. Motz et al. (2019) provide evidence that these data can be interpreted as valid indicators of all dimensions of student engagement. However, self-report instruments of student engagement are still most widely used. Veiga et al. (2014) have analyzed 14 questionnaires used in previous research and point out deficits with regard to quality criteria like reliability and validity.

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The quality of measurement instruments is addressed in the field of psychometrics. In general, a measurement theory provides a mathematical model of how an empirical relative is represented by a numerical relative. Classical test theory focuses on the accuracy of a measurement (Allen & Yen, 2002). In other words, how reliable is the measurement of a given construct by a specific instrument? Reliability can only be estimated, and the most common estimator is "internal consistency" which represents the average correlation of the items of a measurement with each other. In most cases, internal consistency is calculated using Cronbach's alpha (Cronbach, 1951).

In an earlier study, Fredricks & McColskey (2012) analysed a sample of 1,314 citations from research articles to identify named instruments for the measurement of student engagement in various contexts. From the citations, a total of 156 unique instruments could be identified. Since the study was aiming at student engagement in secondary schools, several instruments were excluded. Furthermore, many instruments did not provide sufficient information for analyses, resulting in a total of only 21 instruments. The authors conclude: „We believe that a more systematic and thoughtful attention to the measurement of student engagement is one of the most pressing and imperative directions for future research."

Against the background of a previously conducted systematic review including 243 studies on student engagement and learning with educational technology in higher education (Bond, Buntins, Bedenlier, Zawacki-Richter, & Kerres, 2020), we encountered a remarkable large number of self-report instruments. Given the importance of student engagement in educational research and practice, there is a need to collect and analyze in more detail the instruments used to measure the different dimensions of student engagement.

2. Research Questions

Our secondary analysis is based on a corpus of scholarly literature on student engagement in research on educational technology in higher education from top ranked journals. The analysis extracts the research instruments used in these studies to analyze how they operationalize student engagement, which dimensions are covered, and which dimensions co-occur in these studies.

The study addresses the following research questions:

RQ 1. How many (different) instruments are used in the studies to measure student engagement?

RQ 2. Which types of research instruments are used?

RQ 3. Which dimensions of student engagement are covered?

RQ 4. What is the proportion of psychometrically tested instruments?

RQ 5. How often are instruments referring to certain digital tools / environments or are they generic?

3. Method

Identification of research instruments

In an earlier *systematic review* on student engagement (Bond, Buntins, Bedenlier, Zawacki-Richter, & Kerres, 2020), we were able to identify conditions for the successful use of educational technology in different fields of teaching in higher education for supporting student engagement. The review was based on the question: "Under what conditions does the use of learning technology affect student engagement in higher education?". Four scholarly databases identified 18,068 records of which 4,152 were screened as potentially inclusive. From these, a stratified random sample of 232 articles including 243 studies was drawn.

Based on this corpus of literature, we present results from a secondary analysis focusing on the instruments used for measuring student engagement. The screening and selection process is based on the research question: How are dimensions and facets of student engagement measured and to what quality? We have restricted our analysis to instruments that were accessible online. We were able to identify 246 different instruments. Studies that did not give information about their measurement instrument were excluded in this dataset.

In the following, reference is made to two different data sets. The dataset used for RQ1 is based on the 243 original studies published in the systematic review on student engagement. For RQ 2 to RQ 5, a further dataset was built which consists only of the filtered 246 found instruments.

Categorization of research instruments

Table 1 shows the coding scheme of research instruments:

4. Results

This study wants to reveal the state of measuring student engagement in research on learning with educational technology in higher education. We first look at how many instruments can be identified in the corpus of literature and what type of measurement has been deployed. Then, the different dimensions of student engagement are focused and how they are interrelated. Finally, we analyze the proportion of instruments that provide psychometrical information and whether they are generic or relate to learning with (a certain) educational technology.

4. 1 RQ 1. How many research instruments can be identified?

In the following section, we analyze how many of the 243 studies report identifiable measurement instruments and how often these instruments appear more than once in the corpus.

- 103 of 243 studies (42.4%) do not provide information on the instruments they used, they do not give a reference to a previously published instrument or explain how they developed their instrument.
- 246 unique instruments were identified within the remaining 140 studies (several studies use more than one instrument).
- 36 studies re-use an existing instrument that was published elsewhere.
- 4 instruments were used in more than one publication in our sample:
  - three times: "Motivated Strategies for Learning Questionnaire" (Pintrich et al., 1993)
  - two times: "NSSE" (Kuh, 2001), "Classroom Community Scale" (Rovai, 2002), "Revised Study Process Questionnaire" (R-SPQ-2F) (Biggs et al., 2001)

4.2. RQ 2. Type of measurement: How is student engagement measured?

A total of 246 different research instruments were identified. In the following, we look at the research instruments and the type of measurement they apply. An instrument could be coded more than once.

Type of measurement:

- questionnaires (70.7%, n = 174)
- behavioral traces (18.3%, n = 45)
- observations based 9.8% (n = 24)
- interviews 2.8% (n = 7)
- other 0.8% (n = 2), e.g. learning diaries or test assessment standards

4.3.1. RQ 3a. Which dimensions of student engagement are addressed?

In the following section, we will focus on the dimensions of student engagement. First, we analyze how often each dimension occurs and then, how the dimensions are measured:

- affective learning processes (57.3%, n = 141)
- behavioral learning processes (36.6%, n = 90)
- cognitive learning processes (32.1%, n = 79)
- social learning processes (28.0%, n = 69)
- metacognitive learning processes and learning strategies (13.8%, n = 34)

Table 1
Coding Sheme Measurement Instrument.

Measurement	
Questionnaires	items and questions presented in written format
Interviews	instruments conducted in oral format
Observations	record of observable learning activities, also coding sheme
Behavioral traces	automated data acquisition, for example log data
Other	when none of these categories seem suitable (e.g. learning diaries)
Dimensions of student engagement	
Affective processes	emotions, motivation, satisfaction, but also fear or frustration
Cognitive processes	processing of learning materials, understanding of learning content, creative thinking, and critical reflection
Metacognition learning processes/Learning Strategies	cognitive processes of self-regulation
Behavioral processes	participation and other behavioral processes
Social learning processes	learning processes associated with or based on social interaction
General	all dimensions
Reliability tested	
tested	at least one reliability estimator
not tested	no reliability estimator or other psychometrically indicator
Technology context	
generic tool	instrument does not relate to a digital environment
technology-based tool	instrument addresses the use of a certain technology

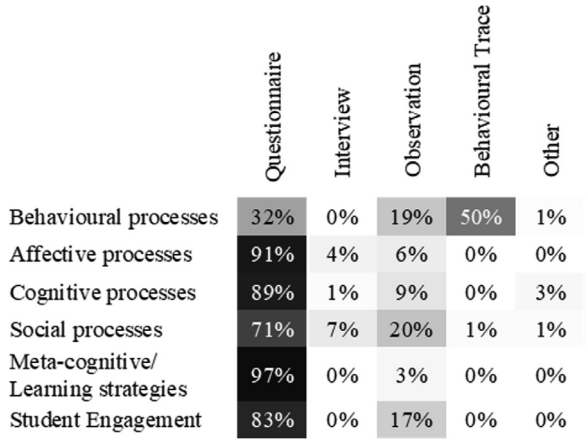

Figure 1. Student engagement dimensions split by instrument types.

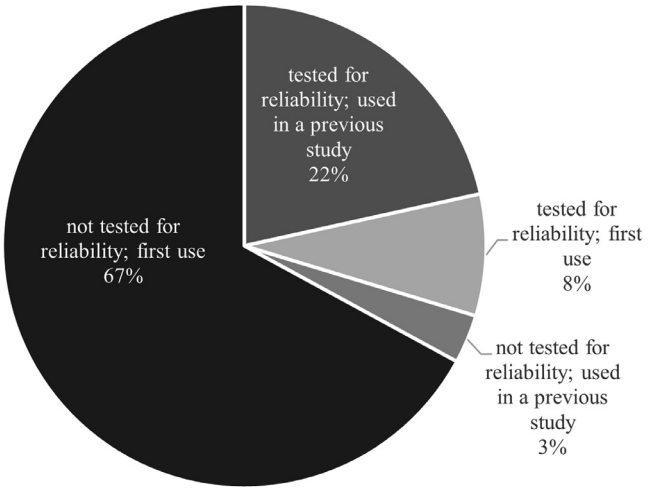

Figure 2. Proportion of instruments classified by (un)tested and whether they have been used previously.

- six instruments assess student engagement as an overall concept (2.4%)

4.3.2. RQ 3b. How are the dimensions distributed across the different instrument types?

In this section, we ask if there are different patterns of how the dimensions of student engagement are measured. To do this, we analyze which type of measurement has been applied related to the different dimensions of student engagement.

Fig. 1 shows that most dimensions are predominantly measured by questionnaires. Only behavioral learning processes are often based on log data. Observations are also relatively common with regard to social learning and behavioral processes, as well as for capturing student engagement as an overall construct.

4.3.3. RQ 3c. What are typical instruments and items for each dimension?

Table 2 shows sample items for all dimensions of student engagement. The detailed questionnaires are available online. A closer inspection of the instruments reveals a larger overlap of items in the case of questionnaires, whereas with interviews and observations the different instruments rely on quite a wider range of different items.

4.4. RQ 4. How many instruments have been psychometrically evaluated?

In the following section, psychometric criteria of the instruments are presented. Here, we apply rather basic criteria for identifying psychometric quality (Cortina, 1993). An instrument can be considered as psychometrically validated if it (at least) reports Cronbach's alpha or another reliability estimator.

- 73 of 246 research instruments (29.7%) are reporting reliability scores.
- Most of the research instruments that report reliability scores have been used before.
- 8 of the previously existing research instruments are not tested for reliability.
- 20 of the research instruments used the first-time report reliability scores.
- 165 of the research instruments used for the first time are not reporting reliability scores (see Fig. 2).
- All psychometrically evaluated research instruments are questionnaires (n=73, 100%).

Table 2
Sample Items for the dimensions of student engagement split by type of instrument

	Questionnaire	Interview	Observation	Behavioral Trace
Behavioral Processes	How confident are you that you will be able to: Attend most taught sessions. (Academic Behavioural Confidence Scale)*; Sander and Sanders (2003)		*Reasons for Participation* *Reasons for not able to Participate* (Ling et al., 2010)	Average # tweets (West et al., 2015)
Affective Processes	The things I am learning in this course will be useful to me. (Course interest survey*; Keller (2010))	Tell us about your experience of using discussion board in WebCT for team collaboration. How has it been? Did you enjoy it? Why or why not? (Du et al., 2016)	*Positive thoughts on the course* Format and content of lectures The LMS and course administration Interaction between teachers and RNs Test, e-mailed questions and examinations format *Negative thoughts on the course* Format and content in lectures The LMS and course administration Interaction between teachers and RNs Test, e-mailed questions and examinations format *Changes they wanted to make* Format and content in lectures The LMS and course administration Interactions between teachers and RNs (Arving et al., 2014)	
Cognitive Processes	I find I can get by in most assessments by memorising key sections rather than trying to understand them. (Revised Study Process Questionnaire (R-SPQ-2F)*; Biggs et al. (2001))	Does peer feedback help you to learn more about how to more effectively write an essay? Why or why not? (Du et al., 2016)	**Elaboration** *Asking for clarification* Poster requests clarification on concept or idea. *Answering clarification* Poster answers request for clarification articulated by previous student. *Challenging others' ideas* Poster challenges others to substantiate or defend their interpretive position. *Giving new knowledge* Poster adds a qualitatively new element (i.e., a new resource or disciplinary perspective). *Giving new perspective* Poster discusses the same topic but provides a completely new way of looking at it. *Reasoning or developing ideas further* Poster engages in sense making or reflection on an issue—there is an effort to probe or elaborate one's own thinking further. (Sharma & Tietjen, 2016)	
Meta-cognitive/Learning Strategies	When reading, I decide what to read closely and what to ignore. (Survey of Reading Strategies*; Mokhtari and Sheorey (2002))		**Metacognition** *Planning* Designing a plan or strategy to carry out individual or group tasks *Monitoring and evaluating* Assessing knowledge, skills and completed tasks; monitoring online learning activities; asking for feedback on completed tasks; acknowledging learning of new skills or knowledge (Lu & Churchill, 2014)	
Social learning process	Keeping in touch with other group members during the day.. (Group Norms Questionnaire*); Wageman (1995)	What types of issues do you prefer to discuss online, theoretical or specific technical issues? Why do you prefer to discuss this opposed to the other? What makes you uncomfortable in discussing certain issues? (Du et al., 2016)	*Group cohesiveness* Appreciation and complementing; sharing life interests outside the classroom; seeking and providing help; and inviting peers to join the learning activities (Lu & Churchill, 2014)	Analyzing social Network activity In-degree interaction value Out-degree interaction value Linked interaction value Interactive score Social Score (C.-M. Chen et al., 2008).
Student engagement (general)	Discussed course topics, ideas, or concepts with a faculty member outside of class (NSSE*; Kuh (2001))		*Academic engagement* The most frequent comment was around the high value students placed on the opportunity to ask questions and have other interaction with academic aspects of the sessions. A frequently reported comment referred to the high value students placed on their ability to share opinions on learning mater *Social engagement* The importance of social interaction with other students was clear in the feedback. One student found the interaction reduced her ability to focus on the learning material and a second disliked social interaction during class time (Leslie et al., 2015)	

* Research Instruments are tested for reliability

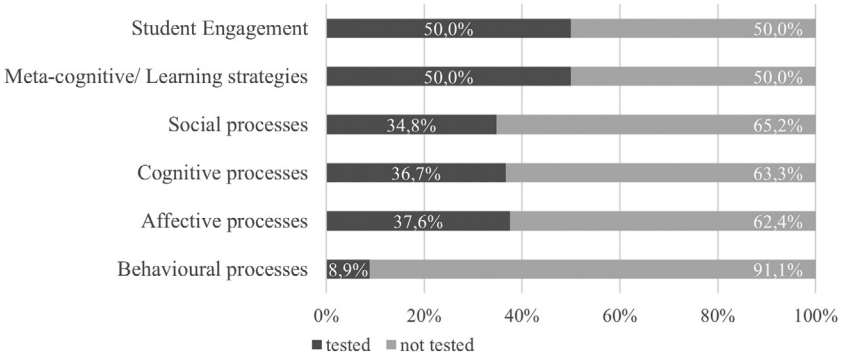

Figure 3. Psychometrically tested instruments split by dimensions of student engagement.

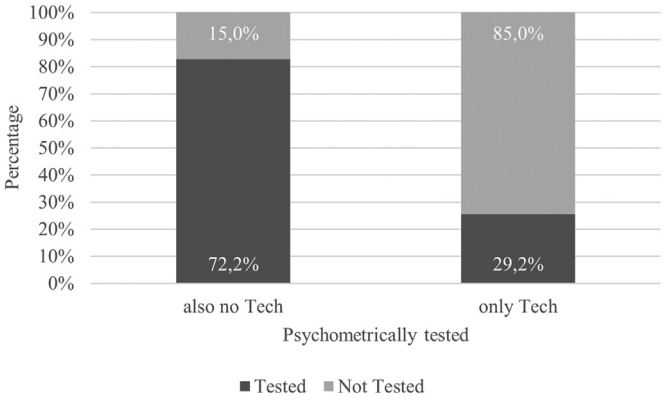

Figure 4. Research instruments divided into tested/not tested and generic/technology basesd.

- The proportion of psychometrically evaluated research instruments is highest for meta-cognitive processes/learning strategies and student engagement (general) with 50% (see Fig. 3).
- The proportion of validated instruments is lowest for the dimension of *behavioural processes* with 50%.
- All evaluated instruments reporting reliability scores are presented in OSF.

4.5. RQ 5. How many of the instruments are generic or refer to digital learning?

In the following section, we look at the share of instruments that are generic and do not refer to a certain technology or explicitly refer to a specific learning technology in their operationalization. We then analyze how this relates to the measurement types, the different dimensions of student engagement and the status of psychometric evaluation.

- 31.7% of the measurement instruments (n=78) are generic and do not relate to a digital learning environment or tool.
- 68.3% explicitly refer to digital technology for learning (n=168).
- 72.2% of the instruments reporting psychometric quality criteria are generic (n=52).
- 85.0% of the instruments not reporting psychometric criteria refer to digital learning (n=147) (Fig. 4).

5. Discussion

This article focuses on how student engagement is measured via a scoping review of literature on technology enhanced learning in higher education. For this purpose, measurement instruments were extracted from 243 studies in a secondary analysis. 103 out of 243 studies in the data set do not reveal their measurement instrument or provide any information about their measurement tool, that would provide an opportunity for an inspection of the instrument or even a replication of the study which seems surprising for articles published in peer-reviewed journals. Replication of studies is a fundamental part of scientific verification and knowledge conservation (Dennis & Valacich, 2014).

For our first research question (*How many (different) instruments are used in the studies to measure student engagement?*), a total of 246 measurement instruments were identified from the 103 studies of the sample that provide information about their instrument. Only four of the instruments were used in more than one publication demonstrating that there are no instruments that already have reached some degree of wider acceptance in the research community.

For the second research question (*Which types of research instruments were used?*) we found in this dataset that over 70% of the instruments use questionnaires. Behavioral traces can be found in nearly 20% of the instruments, followed by observations, interviews and other. This seems plausible, however, for the study of student engagement in learning environments we would expect to see more instruments based on observational data. In a recent review, Nkomo et al. (2021) were astonished to report only a fraction of instruments based on behavioral data. More research should be done in this area to develop further indicators that measure especially behavioral learning processes in a valid and reliable way (Park, 2015). The benefits of focusing more on these approaches as well are obvious. They place less burden on students, can provide feedback quickly to teachers, and do not require course time (Henrie et al., 2018). This would make it easier to develop instruction iteratively.

Answering the third question (*Which dimensions of SE are surveyed?*) of all the student engagement dimensions, affective learning is measured in more than half of all the research instruments in this research field, followed by behavioral engagement processes and cognitive engagement processes. One paper is even based on a framework with 12 dimensions of SE, whereas 22 studies relate to SE as a one-dimensional construct. When Nkomo et al. (2021) criticize, that “there was no shared understanding of what constitutes student engagement with learning technologies” this can be related to a lack of clarity relating to the dimensional structure of SE. In general, a reduction to one of the dimensions does not seem appropriate and the dominance of the affective dimension also does not seem adequate. Fredricks et al. (2004) suggest that not only one construct is surveyed, but several dimensions in order to understand the whole construct. This raises the question of whether self-reports and observations or log data can also be combined.

The fourth question in this study (W*hat is the proportion of psychometrically evaluated instruments?*) leads to the result that only 73 of 248 questionnaires have been tested for reliability, which can be interpreted as a basic measure indicating psychometrical quality. Most instruments at their given stage of evaluation, therefore, must be interpreted as not apt for use in a research project. Overall, there is a very large deficit

of validated instruments. The question arises as to how robust the empirical results generated are if they were collected with research instruments whose reliability is unclear (Boudreau et al., 2001; Kim, 2009). In the worst case, parts of these studies are inconclusive and cannot be replicated. Instruments with reliability scores are most common for metacognitive processes such as learning strategies and least common for behavioral engagement processes and learning outcomes. Affective, cognitive, and social processes are psychometrically tested in about one third of the cases. A Cronbach's α between 0.7 to 0.95 is reported for these research instruments which can be interpreted as sufficient estimation of reliability (Cortina, 1993). The instruments, listed in OSF (A) seem to be a first choice when looking for a research tool studying student engagement.

In further studies and for a deeper inspection of psychometrical quality, we would expect an analysis of validity that would prove that the instrument measures what it intends to measure (Cronbach & Meehl, 1955). As already described above, a preoccupation with the theoretical concept should take place for this. However, the database can be a very good intermediate solution.

For the last question (*How often do dimensions refer to digital tools or are they generic?*) it was found that around one third of the measurement instruments are designed for measuring engagement in generic learning scenarios. Two thirds of the instruments explicitly relate to learning in a digital environment. For comparison, around 70% of the instruments referring to a generic environment report reliability scores and around 15% of the instruments for digital learning settings do meet this standard. This raises the question of the extent to which it is necessary and useful to develop a separate measurement instrument for each technical scenario. For future research, we conclude that the use of generic instruments seems preferable because they relate to more scenarios and therefore might attract more research that will lead to more psychometrically evaluated instruments. When instruments relate to small niches of learning scenarios it is not very probable that they will be able to reach a wider usage and develop the necessary quality criteria. The development and standardization of research instruments are not only time-consuming, but require advanced statistical and content knowledge, as well as a large sample. There is also the question of whether the answers will be different because of explicitly referring to technology.

Student engagement is a construct that is becoming increasingly important, yet this analysis shows that the methods and tools used are not yet mature. Compared to other fields of educational research, we must acknowledge that the methods and instruments used have not reached a certain level of maturity.

In other fields of research on learning, we experience a stronger convergence of methods operationalizing and measuring theoretical constructs. An example is research on cognitive load. In this field of research, there are a limited number of – validated – instruments the research community can rely on, e.g. the rhythm method, the index of cognitive activity (Marshall, 2002; Buchner, Buntins, & Kerres, 2021), and the subjective ratings of mental effort and task difficulty (Paas et al., 2003). Furthermore, there are studies comparing the different instruments revealing the (dis-)advantages of the various measures and demonstrating the validity of the instruments in experimental conditions (Korbach et al., 2018). Also, from the beginning of research on achievement motivation, the measuring of the construct has found intensive consideration and discussion about projective test measures versus questionnaire instruments. A meta-analysis by Spangler (1992) outlines that both types of instruments have demonstrated their validity on a wide range of criteria (cf. McCredie & Morey, 2019). As a variable relating to personality, the construct self-efficacy has motivated the development of a scale that has been validated extensively and applied in many contexts of learning (Sherer & Adams, 1983). It has been updated and improved by G. Chen et al. (2001) and adopted in various languages (Luszczynska et al., 2005).

Compared to these constructs, the research community of student engagement is still developing a broad convergence and agreement on the construct itself and how it should be measured. Nevertheless, more contributions by authors like McCormick et al. (2013) present theoretical models on student engagement recently. Furthermore, it can be stated that an effort for validated and convergent measurement instruments can be observed in the development of the „National Survey of Student Engagement" (NSSE) in the United States which is the most widely known and used questionnaire in the United States in this research community. Robinson and Hullinger (2008) show how students in online programs differ from on-campus universities with respect to several dimensions of the instrument. As Ashwin and McVitty (2015) point out, the NSSE relates to the perception of the courses assigned, the Australian alternative, the University Experience Survey (UES), does comprise the university experience at large.

The NSSE is constantly evolving and changes its items and benchmarks from time to time. It consists of 19 items split into four thematic areas that are not derived from psychometric considerations but are directed at the practical use in higher education development. Therefore, a summary scale often is calculated to mediate these differences and to compare results over years. Currently, the NSSE covers these thematic areas: Academic Challenge, Learning with Peers, Experience with Faculty and Campus Environment. Carle et al. (2009) report on the psychometric qualities of this instrument.

Müller and Braun (2018) show the psychometric quality of a German equivalent of the first three dimensions of the NSSE with a sample of 9.714 alumni from nine universities. A factor analysis of the instrument consisting of nine items confirmed the three hypothesized dimensions.

Other authors have introduced instruments that are rather geared towards research on determinants and effects of student engagement. Gunuc and Kuzu (2015) have developed a scale consisting of 41 items based on a sample of 805 students. They present sufficient data proving the reliability and validity of the instrument. S.-H. Lin and Huang (2018) report on the 20-item Student Course Engagement Scale (SCES) demonstrating high reliability and factorial validity as well as high correlations with other engagement indicators. Recently, Zhoc et al. (2019) have introduced the „Higher Education Student Engagement Scale (HESES)", a 28-item scale with sufficient levels of reliability and criteria validity. There is a scale on student engagement especially in the field of mathematics of science from M.-T. Wang et al. (2016) and Mameli and Passini (2017) present a scale for the use in secondary schools which has been tested with 1,210 Italian secondary school students. Darr (2012) provides details for a questionnaire with students in primary schools.

An important note on these instruments is the fact that most of them relate to the sector of Higher Education and that most of these instruments are designed for generic learning situations and do not explicitly refer to learning in the context of Educational Technology. Moreover, we still see a missing initiative from the broad research community for more convergence. Instruments like the NSSE indirectly promote a common sense of the construct, but a scientific debate on the construct and what we agree on measuring in student engagement would be helpful for the heterogenic community.

6. Conclusions

More convergence in research on student engagement and education technology seems important to enable a comparison and synthesis of studies in the field. A common definition of student engagement is needed to advance in convergent findings and a shared understanding of what is being measured. This could then support the consolidation of theory building as well as new theoretical approaches that consider the complexity of learning with education technology.

The state of student engagement measurement does not fulfil scientific quality requirements. Improvements are urgently needed. In our eyes, it first needs a deeper examination of the theoretical construct itself. This requires looking at how it can be operationalized and validated. Researchers dealing with this construct should be aware of this

fuzziness. In addition to a theoretical clarification and a measurement-theoretical validation, a fuzzy-logical approach (Buntins, Buntins, & Eggert, 2016) could be helpful.

It should be noted that future research on student engagement is in need of a meta-discussion. Furthermore, during this, there should be no further reliance on non-validated measurement instruments. All instruments that have been extracted from our analysis have been compiled in a database that is publicly available on the web (https://learninglab.uni-due.de/instruments-collection). It aims to serve as a basis for the dissemination of available instruments for measuring student engagement and to lead to an increased comparability of studies in the field of educational technology in higher education.

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Availability of data and materials

The full list of measurements is made available at: https://learninglab.uni-due.de/instruments

Authors' contributions

Prof. Dr. Michael Kerres wrote the project proposal and secured project funding. Katja Buntins and Anna Heinemann searched and coded the measurement instruments.

Katja Buntins delivered a first draft of the paper that was revised together with Prof. Dr. Michael Kerres and Anna Heinemann over several cycles. All authors read and approved the final manuscript.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Questionnaire name	Reference	Behavioural Processes	Affective Processes	Cognitive Processes	Social Processes	Metacognitive Processes/ Learning Strategies	Student Engagement	Number Items	Number Dimensions	Generic
Academic Behavioural Confidence scale (ABC)	(Sander & Sanders, 2003)	X	X			X		24	1	Yes
Academic Engagement Form	(Richardson et al., 2004)		X		X	X		33	12	Yes
Academic motivation scale (ams-c 28)	(Vallerand et al., 1993)		X					28	7	Yes
Academic Volitional Strategy Inventory (AVSI)	(McCann & Turner, 2004)		X			X		20	3	Yes
Achievement Emotions Questionnaire	(Peixoto et al., 2015)		X					24	6	Yes
Activation-Deactivation adjective check list	(Thayer, 1986)		X					20	4	Yes
Blog Motivation Questionnaire by Yang and Chang	(C. Yang & Chang, 2012)		X	X				3	1	No
Classroom Community Scale	(Rovai, 2002)			X	X			20	2	Yes
Cognitive load questionnaire developed by OuYang, Yin, and Wang	(OuYang et al., 2010)			X				7	1	Yes
Computer Self-Efficacy Measure	(Compeau & Higgins, 1995)		X					10	1	No
Concentration questionnaire for mobile learning	(I. H. Chen et al., 2013)			X				10	1	No
Course Experience Questionnaire	(Ramsden, 1991)		X	X	X			37	6	Yes
Course interest survey	(Keller, 2010)		X					33	1	Yes
Current Student Inventory	(Ehrmann & Zúñiga, 1997)		X					11	3	Yes
E-Course Satisfaction Scale (ECSS)	(Gecer & Topal, 2015)		X							No
Effectiveness of clicker technology	(Laxman, 2011)		X	X	X			7		No
Engagement Scale by Sun	(Sun & Rueda, 2012)	X	X	X			X	15	3	Yes
Ennis-Weir Test of Critical Thinking	(Ennis & Weir, 1985)			X						Yes
External on-line questionnaire	(Tsai, 2012)	X	X	X				15	3	No
Feedback perceptions Scale	(Strijbos et al., 2010)		X	X				18	3	No
Fragebogen zur Evaluation von Vorlesungen (FEVOR)	(Staufenbiel, 2000)		X					27	4	Yes
Group Norms by Wageman	(Wageman, 1995)	X			X			7	2	Yes
Informal Collaborative Learning Practice	(Shell et al., 2005)		X	X	X			5	1	Yes
Interest in the Class Scale	(Gregory et al., 2016)		X					3	1	Yes
Internal Control Index (ICI)	(Duttweiler, 1984)		X		X			28	2	Yes
Internet self-efficacy Scale	(Eastin & LaRose, 2000)		X					10	1	No
Intragroup conflict scale	(Jehn, 1995)		X		X			8	2	Yes
Intrinsic, Extraneous und Germance Load Scale	(Leppink et al., 2013)			X				10	3	Yes
Learning and study strategies inventory (lassi)	(Weinstein et al., 1987)		X	X		X		63	10	Yes
Learning effectiveness through Blogs by Yang	(C. Yang & Chang, 2012)			X	X			3	1	No
Learning experience survey	(Choi et al., 2008)		X					9	1	Yes
Learning Mathematics Anxiety – Short version	(Plake & Parker, 1982)		X					34	2	Yes
Measure of Personal Responsibility	(Mergler et al., 2007)		X			X		30	2	Yes

(*continued on next page*)

Questionnaire name	Reference	Behavioural Processes	Affective Processes	Cognitive Processes	Social Processes	Metacognitive Processes/ Learning Strategies	Student Engagement	Number Items	Number Dimensions	Generic
Mental-effort rating scale by Paas	(F. G. Paas, 1992)			X				1	1	Yes
Metacognitive Awareness of Reading Strategies Inventory	(Mokhtari & Reichard, 2002)			X		X		30	3	Yes
Motivated Strategies for Learning Questionnaire	(Pintrich et al., 1993)		X					31	5	Yes
Motivational Belief Scale	(Pintrich, 1989)		X					36	6	Yes
National Survey of Student Engagement	(Kuh, 2001)	X	X	X		X	X	28	10	Yes
Online Cooperative Learning Attitude Scale	(Korkmaz, 2012)		X		X			17	2	No
Online peer interaction	(C. Yang & Chang, 2012)				X			3	1	No
Participants' involvement by Park	(Park, 2015a)	X		X				2	2	Yes
Perceived Effort of Collaboration	(Dishaw et al., 2011)				X			4	2	No
Perceptions of the use on their engagement & learning	(Dunn et al., 2013)	X	X	X	X		X	17	2	Yes
Personal Report of Communication Apprehension (PRCA-24)	(McCroskey, 1993)		X		X			24	4	Yes
Preference for Autonomy at Work	(Wageman, 1995)				X			8	1	Yes
Problem Solving Inventory	(Heppner & Petersen, 1982)			X		X		35	3	Yes
Questionnaire of satisfaction with courseware integration	(Tsai, 2012)		X	X				15	1	No
Review of Personal Effectiveness and Locus of Control	(Richards et al., 2002)		X			X		34	1	Yes
Revised Approaches to Studying Inventory (RASI) – Short Form	(Duff, 1997)			X		X		30	3	Yes
Revised Personal Involvement Inventory	(Entwistle et al., 2000)		X					10	1	Yes
Revised Study Process Questionnaire (R-SPQ-2F)	(Biggs et al., 2001)			X		X		20	2	Yes
Satisfaction with the Discussion Activity in Facebook	(Orawiwatnakul & Wichadee, 2016)		X	X	X			10	1	No
Satisfaction with the mathematics archival system	(Cascaval et al., 2008)	X	X	X				20	1	No
Science motivation questionnaire II	(Glynn et al., 2011)		X					25	5	Yes
Self-Directed Learning Readiness Scale	(Fisher & King, 2010)		X			X		30	3	Yes
Self-Efficacy Scale for Scholarly Writing in English	(Kavanoz & Yüksel, 2016)		X	X				20	2	No
Self-report measures of group process	(Green & Taber, 1980)		X		X			23	5	Yes
Situational Interest Scale	(A. Chen et al., 1999)		X	X				19	5	Yes
Social Ability Instrument	(C.-C. Yang et al., 2006)			X	X			30	5	No
Social presence in an online learning	(Crim, 2006)		X					44	3	No

(*continued on next page*)

Questionnaire name	Reference	Behavioural Processes	Affective Processes	Cognitive Processes	Social Processes	Metacognitive Processes/ Learning Strategies	Student Engagement	Number Items	Number Dimensions	Generic
SPOCK Collaboration Subscale	(Shell et al., 2005)				X			5	1	Yes
Student attitudes towards classroom innovation	(Doolen et al., 2003)		X					37	6	Yes
Student Evaluation of Educational Quality Questionnaire (SEEQ)	(Marsh, 1982)		X	X	X	X		36	9	Yes
Student resistance to group work	(Smith et al., 2011)				X			6	1	No
Students' emotion management in online collaborative groupwork	(Xu et al., 2013)		X		X	X		50	8	Yes
Students' Attitudes Towards the English Learning Approach	(Zhang & Han, 2012)		X		X	X		8	1	Yes
Students' Attitudes towards the Blended Learning Approach	(Zhang & Han, 2012)		X			X		8	2	Yes
Survey of Reading Strategies	(Mokhtari & Sheorey, 2002)					X		30	3	Yes
Survey on students' perception of support and course satisfaction	(Lee et al., 2011)		X		X			26	3	Yes
The Instructional Materials Motivation Survey (IMMS)	(Keller, 2010)		X					36	4	Yes
The Motivation for Reading Questionnaire (MRQ - R)	(Wigfield & Guthrie, 1997)		X					53	11	Yes
Web User Self-Efficacy Scale (WUSE)- Short Version	(Eachus et al., 2006)		X					20	4	No
Writing Motivation Questionnaire by Nie adopted from Zhang	(Nie & Lau, 2010)		X					9	2	Yes

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