



Stirring a Secret Sauce: A Literature Review on the Conditions and Effects of Authentic Learning

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Abstract

The present conceptual literature review analyzes 50 studies that systematically examined the effects of authentic learning settings on cognitive or motivational learning outcomes. The analysis focuses on describing the context of the studies, the design elements of authentic learning settings, and the pursued intentions of authenticity. The review further describes the effects of authentically designed learning settings on cognitive outcomes, motivational outcomes, and learners' perceived authenticity revealed by previous research. Building on these findings, we conducted Epistemic Network Analysis (ENA) of contrasting cases to identify design elements and intentions of authenticity characterizing studies that show high effectiveness for cognitive and motivational outcomes versus those with low effectiveness. The ENA results suggest, for instance, that providing authentic materials (as a design element of authentic learning settings) to resemble real-life experiences (as an intention of authenticity) could be a double-edged sword, as they feature both authentically designed learning settings with low effects on *cognitive* outcomes and settings with high effects on *motivational* outcomes. Overall, the results of the present literature review point to critical limitations of previous research, such as a lack of clear definitions and operationalizations of *authentic* learning. Consequently, we draw specific conclusions about how future research could improve our understanding of how to create and implement powerful methods of authentic learning.

Keywords Authentic learning · Conceptual literature review · Epistemic Network Analysis · Perceived authenticity · Cognitive and motivational effects

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Introduction

Over the last 30 years, research on authentic learning has increased exponentially, and several researchers have attempted to define, classify, and operationalize the term *authentic learning* in numerous literature reviews and theoretical frameworks (see the next section for an overview). Building on the argument that learning is situated and that the context therefore affects the construction of knowledge (Brown et al., 1989), researchers usually identify the same goal for the design of authentic learning settings: to contextualize learning experiences such that learners recognize the value, utility, meaning, and functionality of the knowledge to be acquired, while promoting both cognitive (e.g., development of deep understanding) and motivational (e.g., development of intrinsic motivation to learn) effects (Lepper, 1988; Newmann & Wehlage, 1993).

Given these hypothesized benefits of authentic learning, we ask whether previous research on authentic learning reveals positive effects of authentically designed learning settings on learners' cognitive and motivational outcomes. Furthermore, in light of the many classifications and operationalizations of authenticity in literature reviews and theoretical frameworks, we ask whether the effectiveness of authentic learning is related to specific design elements implemented in authentic learning settings and to particular intentions of authenticity.

However, we do not aspire to conduct a quantitative meta-analysis that tries to identify the *true* effect size or to examine and explain varying effect sizes (e.g., Borenstein et al., 2010) of authentically designed learning settings. As studies on the effectiveness of authentic learning differ according to several features (e.g., participants, learning domain, operationalization of authentic learning, dependent variables), it seems inappropriate to conduct a meta-analysis (see also Elson, 2019) and to apply traditional meta-analytic methods such as estimating the mean effect size of authentic learning or examining the moderators of this effect.

Consequently, the present conceptual literature review aims to make sense of the broad and conceptually diverse research on authentic learning. First, we systematically determine and describe the differences and similarities between studies on authentic learning with respect to the research contexts, the design elements used for creating authentic learning settings, the intentions of authenticity underlying the design of the settings, and the investigated effects. Next, we conduct contrasting-cases analyses in order to identify design elements and intentions of authenticity that characterize effective authentic learning settings. Specifically, we compare the studies showing high effectiveness (for either cognitive or motivational outcomes) of authentic learning with those showing low effectiveness.

To identify categories for our analysis, the following sections provide a description of different operationalizations of *design elements* of authentic learning settings as well as different classifications of *intentions of authenticity* that determine the design of authentic learning settings. We further briefly describe the effects associated with authentic learning and the mechanisms hypothesized to underlie the effectiveness of authentically contextualized learning.

Table 1 Foci of previous literature reviews and theoretical frameworks

	Classification of authentic learning (<i>Intentions of authenticity</i>)	Operationalization of authentic learning (<i>Design elements</i>)
Shaffer and Resnick (1999)	✓	
Herrington and Oliver (2000)		✓
Doyle (2000)	✓	
Rule (2006)		✓
Polman (2012), Polman et al. (2018)	✓	
Strobel et al. (2013)	✓	
Betz et al. (2016)		✓
Fougt et al. (2019)	✓	
Hod and Sagy (2019)		✓

Authentic Learning: Design elements, Intentions, Effects, and Mechanisms

Research on authentic learning has grown strongly since the turn of the millennium. Parallel to this increase, scholars have begun to classify different kinds, meanings, senses, types, or facets of authenticity—referred to here as intentions—and to operationalize elements, components, characteristics, or designs of authentic learning settings—referred to here as design elements—in literature reviews and theoretical frameworks (see Table 1 for an overview).

In 1999, Shaffer and Resnick analyzed the definitions of *authentic learning* in 100 randomly selected articles. The authors identified four “kinds” of authenticity and combined them in their conceptualization of *thick authenticity* (Shaffer & Resnick, 1999). In 2000, Herrington and Oliver developed an instructional design framework for authentic learning environments based on the relevant literature, which includes nine design “elements of situated learning” (Herrington & Oliver, 2000). In the same year, Doyle (2000) distinguished three different “meanings” of authenticity. In 2006, Rule conducted a content analysis of 45 articles and detected four “components” of authentic learning settings (Rule, 2006). In 2012, building primarily on findings from his own research (Polman, 2012; Polman et al., 2018), Polman named three “senses of authenticity” in learning environments. In 2013, Strobel and colleagues analyzed 59 definitions and descriptions of “authenticity” and “authentic experience” in the context of engineering education. Their analysis resulted in four “types” of authenticity (Strobel et al., 2013). In 2016, Betz and colleagues developed a theoretical model of authenticity in learning contexts, which describes different “characteristics” but also mechanisms and outcomes of authentically designed learning settings (Betz et al., 2016). In 2019, Hod and Sagy analyzed 28 authentic learning environments and identified 12 different “designs” of authentic learning settings (Hod & Sagy, 2019). In the same year, Fougt et al. (2019) conducted an update of Shaffer and Resnick’s (1999) literature review and

Table 2 Design elements of authentic learning settings named in four different literature reviews

Design elements	Herrington and Oliver (2000) ^a	Rule (2006)	Betz et al. (2016)	Hod and Sagy (2019)
Collaboration	✓	✓	✓ ^c	✓
Complex problems/tasks	✓ ^b	✓	✓	
Inquiry/investigation		✓	✓	
Experts/practitioners	✓		✓	✓
Real-life/professional setting	✓		✓	✓
Real-life materials/cultural tools			✓	✓
Authentic assessment	✓			
Reflection	✓			
Articulation of knowledge	✓			
Coaching and scaffolding	✓			
Multiple roles and perspectives	✓			
Empowerment/personalization		✓		
Innovation			✓	
Authentic timeframe				✓

^aNote that Herrington et al. (2003) also developed a list of ten design elements which differ slightly from the nine elements described by Herrington and Oliver (2000) and by Herrington et al. (2010)

^bHerrington and Oliver (2000) refer to the two design elements “complex problems/tasks” and Inquiry/investigation” in their description of the design element “authentic activity”

^cBetz et al. (2016) do not explicitly name “collaboration” as a design element of authentic learning settings but describe that the social setting of the real-world context to be emulated should be considered

identified five “meanings” or “facets” of authenticity. In the following sections, we first synthesize common design elements described in the four operationalizations of authentic learning (see Table 1, right column) and then compare the five classifications of different intentions of authenticity (see Table 1, left column).

Design Elements of Authentic Learning Settings

We synthesized the design elements of authentic learning settings described in the four operationalizations of authentic learning (see Table 1) by Herrington and Oliver (2000), Rule (2006), Betz et al. (2016), and Hod and Sagy (2019). As can be seen in Table 2, authentic learning is assumed to emerge from the interaction of multiple design elements.

An authentic learning setting is characterized by learners who *collaboratively* try to solve a *complex and ill-structured real-world problem* through *self-directed inquiry and investigation*. Such investigations should be conducted together with *practitioners or experts*, in a *real-world or professional setting*, and by using *materials and tools* that are either typically also applied by practitioners or are used in daily life.

Another design element is *authentic assessment*, according to which authentic learning settings should provide assessments of learning which are “seamlessly integrated with the activity” and its tasks (Herrington & Oliver, 2000, p. 27).

Rarer design elements, such as *authentic timeframe* or *innovation*, are named in only one of the four operationalizations of authentic learning (see Table 2), but generally overlap with the more common design elements of authentic learning. For instance, *reflection*, *articulation of knowledge*, *coaching*, and *scaffolding*, as well as *multiple roles and perspectives*, can be promoted through collaboration between learners, conducting one’s own investigations, work on complex and open-ended problems, and/or contact with experts (see Herrington & Oliver, 2000). The feature *empowerment/personalization* emphasizes the need to allow learners to make their own choices (e.g., when interpreting literature or solving a problem), which can be achieved through learner-centered activities and open-ended problems (see Rule, 2006). Thus, empowerment/personalization overlaps with some of the more common design elements, such as inquiry/investigation and complex problems/tasks.

A further element often used for implementing authenticity in learning settings is some kind of *technology*. Herrington and Oliver (2000), for instance, described how technology can be applied to design a learning setting that features all design elements of authentic learning. Later on, the authors focused on e-learning contexts within authentic learning settings (e.g., Herrington et al., 2010). Hod and Sagy (2019) likewise focused computer-supported learning environments in their analysis of different designs for authenticity.

In our conceptual analysis of studies, we look at the eight main design elements of authentic learning settings (i.e., collaboration, complex problems/tasks, inquiry/investigation, experts/practitioners, real-life/professional setting, real-life materials/cultural tools, authentic assessment, and technology) and analyze how they interact. The specific design and utilization of these elements, and the interplay and importance of certain elements in order to authentically contextualize learning experiences, depends on what we call the *intentions of authenticity* described below.

Intentions of Authenticity

Different classifications of authenticity often encompass similar kinds, meanings, senses, types, or facets of authenticity. We synthesized the five classifications of authenticity (see Table 1) outlined by Shaffer and Resnick (1999), Polman (2012), Strobel et al. (2013), Doyle (2000), and Foug et al. (2019) and extracted the following four intentions of authenticity: (1) to create personally meaningful learning activities, (2) to emulate the work of professionals of a certain discipline, (3) to connect learners with a community of practitioners, and (4) to reflect experiences from real/daily life.

All of the authenticity types named in the first row of Table 3 (i.e., personal authenticity, authentic to self, value authenticity, and child-centered authenticity) describe the same intention, namely to create a learning scenario in which the tasks and activities are personally meaningful to the learners, in line with their interests, and engaging (Shaffer & Resnick, 1999; Polman, 2012; Doyle, 2000). This may be

Table 3 Comparison of different classifications of authenticity

Shaffer and Resnick (1999)/Fougt et al. (2019)	Polman (2012)/Polman et al. (2018)	Strobel et al. (2013)	Doyle (2000)
Personal authenticity	Authentic to self	Value authenticity	Child-centered authenticity
Disciplinary authenticity	Authentic tools	Task authenticity	Subject-centered authenticity
	Authentic to others	Impact authenticity	Situated authenticity
Real-world authenticity			Context authenticity
Authentic assessment			
Teacher authenticity ^a			

^aOnly part of the classification by Fougt et al. (2019)

achieved by self-directed activities which allow learners to explore and determine the steps for completing the activity on their own (Polman et al., 2018; Strobel et al., 2013) and/or by activities that are relevant to learners' lives (Shaffer & Resnick, 1999), such as "conduct[ing] interviews with individuals in their neighborhoods to design a transportation system" (Strobel et al., 2013, p. 149).

The types of authenticity represented in the second row of Table 3 (i.e., disciplinary authenticity, authentic tools, task authenticity, and subject-centered authenticity) share the intention of placing learners in the role of a professional by providing them with access to methods and tools that are typical for the work of professionals or that emulate certain processes and features of professionals' work in a specific discipline (Polman et al., 2018; Shaffer & Resnick, 1999; Doyle, 2000). Strobel et al. (2013) give the following example for such a scenario: "In a high school engineering learning module, the students are trained to use AutoCAD, which is a popular tool used in the industry where the students may eventually work" (Strobel et al., 2013, p. 149).

The kinds of authenticity shown in the third row of Table 3 (i.e., authentic to others, impact authenticity, and situated authenticity) also focus on placing learners in the role of a professional/practitioner, but emphasize the intention to connect the learners to a wider community (of practitioners) outside of the classroom (Polman, 2012; Doyle, 2000). This might be achieved when students present their learning products to authentic audiences (Polman et al., 2018; Strobel et al., 2013), for instance when "students' analysis of traffic in front of their school is reported to the city planning office and influences the design of pedestrian crossings and other road construction" (Strobel et al., 2013, p. 149).

A further type of authenticity, listed in the fourth row of Table 3 (i.e., real-world authenticity and context authenticity), aims less at emulating the work of professionals but rather intends to "resemble daily life experiences" (Strobel et al., 2013, p. 146). "The idea is that people should learn by doing the same kinds of things that they will do in 'real life' outside of the environment in which learning takes place" (Shaffer & Resnick, 1999, p. 198). For instance, newspapers or comic books might be used in language learning classes (Shaffer & Resnick, 1999) or students might be asked to apply mathematical principles to design a toy (Strobel et al., 2013).

In the aforementioned analyses, Shaffer and Resnick (1999) as well as Foug et al. (2019) identified *authentic assessment* as a further kind of authenticity, which emphasizes the alignment of assessment with learners' actual learning activities. However, authentic assessment differs from the four intentions of authenticity described above, as the authenticity of an assessment presumably depends on one or more of these intentions. Moreover, the authenticity of assessment is not primarily concerned with the authentic contextualization of learning experiences, but rather with the authentic contextualization of the *evaluation* of learning. Thus, while the four intentions determine the design of an entire learning setting, the nature of assessment authenticity differs in that it refers to the design of one particular feature of a learning setting. As such, we do not address it as an equivalent, further intention of authenticity in the present paper. Instead, we use authentic assessment as a further design element of an authentic learning setting (see Table 2 and previous section), as proposed by Herrington and Oliver (2000).

From the literature, Foug et al. (2019) identified teacher authenticity as a further kind of authenticity that refers to the values, beliefs, behaviors, and educational goals of teachers. Teachers act as authentic persons when, for instance, they have a genuine interest in the subject, their students, their students' thinking, and their teaching activity. However, as teacher authenticity can hardly be achieved by implementing certain design elements in a learning setting, we do not consider teacher authenticity in the present analysis.

In summary, we include four intentions of authenticity (i.e., creating personally meaningful learning activities, emulating the work of professionals of a certain discipline, connecting learners with a community of practitioners, and reflecting experiences from real/daily life) as categories in the present analysis. As Shaffer and Resnick (1999) call for unifying the different kinds of authenticity in order to achieve *thick authenticity* in learning settings, we also analyze how these different intentions of authenticity interact. We particularly look at the interplay between the different intentions of authenticity and the different design elements of an authentic learning setting. We understand the intentions of authenticity as the overarching determination or definition of authenticity in learning settings. The selection and design of the elements of an authentic learning setting builds on these intentions, and it is likely that certain design elements are more strongly linked to certain intentions than others. For instance, implementing the design element *real-life materials/cultural tools* is probably especially important for learning settings that seek to resemble everyday experiences or that intend to emulate the work of professionals. However, elements such as real-life/professional setting, complex problem/task, and inquiry/investigation may be equally important for achieving these intentions. Presumably, the design element of *collaboration with experts/practitioners* is especially relevant for learning settings that aim to connect learners with a community of practitioners. Nevertheless, the design elements can be used and implemented in different ways in order to create authenticity in learning and teaching contexts, and their specific utilization is determined by the intended authenticity. The present conceptual analysis of studies on the effectiveness of authentic learning aims to investigate the actual interplay between the different design elements of an authentic learning setting and the different intentions of authenticity.

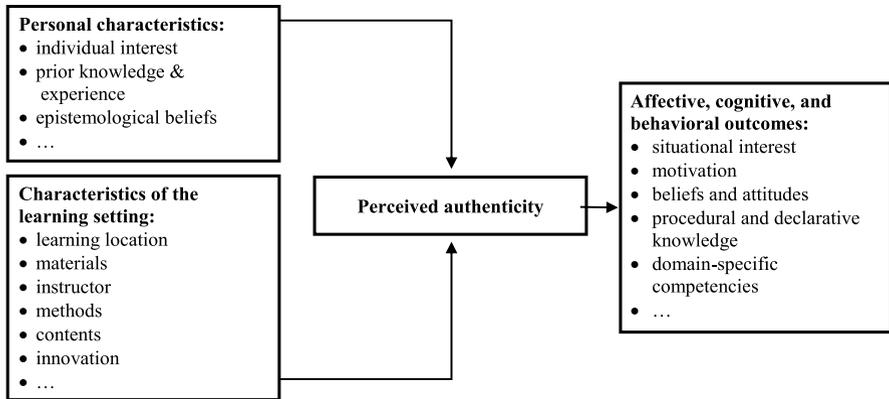


Fig. 1 Model of authenticity in learning contexts adapted from Betz et al. (2016)

Cognitive and Motivational Effects

Independently of the intentions and design elements of authentic learning settings, motivational and cognitive learning outcomes might be promoted by an authentic contextualization of learning experiences, which demonstrates the relevance and functionality of learning contents and activities to the learners (e.g., Brown et al., 1989; Lepper, 1988; Newmann & Wehlage, 1993). In their authenticity model (see Fig. 1), Betz and colleagues (2016) give examples of different outcomes that may be fostered by authentically contextualized learning.

In the present review, we analyze whether previous research demonstrated the hypothesized benefits of authentic learning settings on cognitive and motivational learning outcomes. Here, the term *cognitive effects* refers to all learning outcomes that result from students' processing of information, and is thus used to describe the examined impacts of authentic learning on students' achievement, performance, knowledge and skill acquisition, transfer ability, understanding, problem-solving ability, and so on. *Motivational effects* refer to all feelings and emotions that occur during learning and that affect students' interest and motivation to further engage in certain learning endeavors. Thus, this category is used to describe the investigated impacts of authentic learning contexts on students' attitudes towards the learning environment/ satisfaction, (situational) interest, (intrinsic) motivation, perceived self-efficacy, and so on.

Perceived Authenticity as Underlying Mechanism

The authenticity model depicted in Fig. 1 implies that the potential effects of authentically designed learning settings are mediated by learners' perceived authenticity (Betz et al., 2016). According to Barab et al. (2000), "what is authentic to the teacher may not be authentic to the student, and what is authentic to the student may not be authentic to the teacher" (p. 38), as authenticity is considered highly

subjective. Thus, without assessing learners' perceived authenticity, it remains questionable "what the relevance is of an authentic learning environment that is perceived as authentic in the eyes of teachers, but not in the eyes of students" (Gulikers et al., 2005, p. 513). In the present literature review, we analyze whether studies on the effectiveness of authentic learning examined students' perceived authenticity.

The Present Review

Against this background, the present literature review investigates the following four research questions:

- (1) Which design elements have been implemented to create authentic learning settings and which intentions of authenticity underlie these settings?
- (2) Which effects of authentic learning have been demonstrated on *cognitive learning outcomes* and how are these effects related to the interaction between particular intentions of authenticity and design elements of authentic learning settings?
- (3) Which effects of authentic learning have been demonstrated on *motivational learning outcomes* and how are these effects related to the interaction between particular intentions of authenticity and design elements of authentic learning settings?
- (4) Did previous research on the effectiveness of authentic learning take into account learners' perceived authenticity of the learning setting?

Method

To investigate our research questions, we conducted a conceptual literature review of studies on the effectiveness of authentic learning. To identify design elements and intentions of authenticity in the studies that demonstrated beneficial effects (either on cognitive or motivational outcomes) and to investigate how these design elements and intentions of authenticity interact (see Research Questions 2 and 3), we conducted Epistemic Network Analysis of contrasting cases (ENA: Shaffer et al., 2016). Specifically, we compared the studies that revealed moderate and large effects (i.e., $d > 0.5$) with the studies that revealed small, no, or negative effects (i.e., $d < 0.5$). ENA allows to measure the co-occurrence of elements in coded data and thus to identify the connections between them by modeling the weighted structure of these connections and illustrating this structure in dynamic network models (Shaffer & Ruis, 2017; Shaffer et al., 2016). Hence, the resulting ENA models enabled us to describe the interaction of the design elements and intentions of authenticity that characterize the learning settings implemented in the two groups of studies (i.e., low effectiveness versus high effectiveness), and to examine whether the patterns of design elements and intentions differ between these two groups. In this process, we did not seek to draw any causal conclusions. Rather, the results of our conceptual literature review should serve as a basis for formulating and testing causal claims in future research. Moreover, in contrast to a quantitative meta-analysis (see, for instance, Borenstein et al., 2010), our conceptual literature review does not aim to

find the *true* effect size of authentically designed learning settings or to explain the variation in effect sizes of authentic learning. Instead, the primary goal was to make sense of and organize the diversity within the broad and growing body of research on authentic learning.

Literature Search and Inclusion Criteria

For the purpose of our contrasting-cases analysis of high vs. low effectiveness of authentic learning, we exclusively reviewed empirical studies that systematically examined the effects of authentic learning in an experimental or quasi-experimental design. Thus, we excluded studies with a qualitative research design (e.g., case studies), and focused on studies that varied the authenticity level of features of the learning setting as independent variable by implementing and comparing at least two treatments (i.e., authentic learning setting versus less or non-authentic setting). We also excluded studies in which a treatment group was compared to a control group without any intervention, as such studies merely revealed whether there was an effect of authenticity, without providing any information about this effect. However, studies with a control or comparison group were included if this group received traditional instruction for comparison with a non-traditional and more authentic learning method (with the same learning content). In summary, the studies had to meet the following inclusion criteria:

- (1) Implementation of an experimental or quasi-experimental design.
- (2) Variation of the authenticity level of the learning setting as independent variable by implementing and comparing at least two treatments.
- (3) Report of sufficient data on the effects of authentic learning (i.e., at least means and standard deviations).
- (4) Availability in English.

After identifying studies that met the aforementioned criteria, we further excluded one study that incorporated a within-subjects design due to possible sequence effects. To further standardize our data set and additionally avoid potential duplicate publications, we excluded conference papers and dissertation theses (the literature search yielded no dissertation theses and only four conference papers that met the inclusion criteria).

In a first round of literature search in September 2018, we searched the databases ERIC and EBSCOhost using the keywords *authentic learning AND study*, yielding a large number of results (i.e., $N=516$) but only a small number meeting the inclusion criteria (i.e., $N=5$). Therefore, in a second round of literature search in October 2019, we additionally used Google Scholar and the following keywords:

- authentic learning AND experimental study
- authentic learning AND effect
- situated learning AND experimental study
- situated learning AND effect

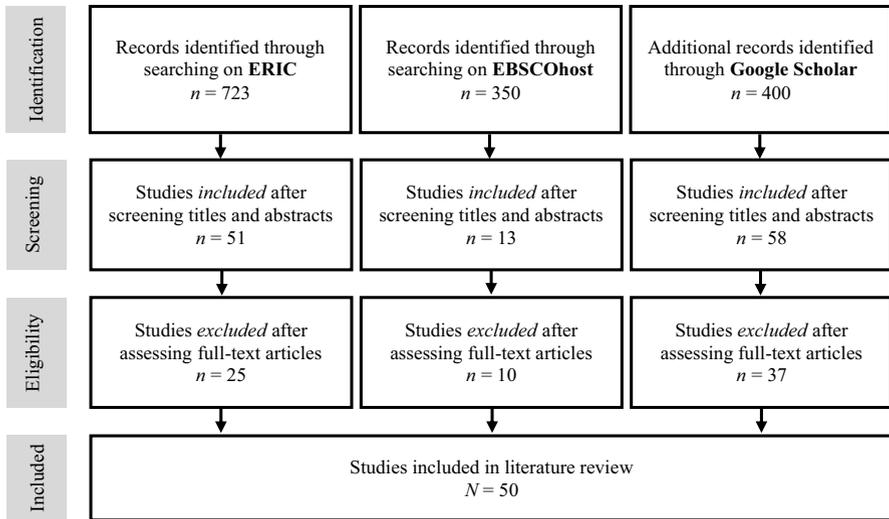


Fig. 2 Study selection flow chart

Due to the large number of results on Google Scholar (more than 10,000) and as Google Scholar's ranking algorithm tries to show the most relevant results (based on the citation frequency of the articles; see Beel & Gripp, 2009), we only checked the first 50 results per keyword. Finally, in July 2020, we conducted a third round of literature search to identify studies published in 2020, using the same procedure as in the second round.

After excluding duplicates and after checking titles and abstracts, 122 results of the three rounds of literature search seemed to fit the keyword criteria. Assessing the full-text articles for eligibility led to the exclusion of 72 papers. Thus, in total, the literature search resulted in 50 studies that met the inclusion criteria. Figure 2 gives an overview of the total number of search results per database.

Study Coding

The 50 studies were coded with respect to the context of the studies, the design elements of the learning settings, and the intentions of authenticity. The first author and a second rater coded 100% of the studies; in the case of disagreement, consensus was reached by discussion.¹

Regarding the *context of the studies*, the following information was coded: study design (experimental vs. quasi-experimental), sample size per condition ($N < 30$ vs. $N > 30$), duration of treatment (multiple training sessions vs. single training session), and learning domain (language, STEM, social sciences and humanities, vocational

¹ Prior to discussion, the two raters reached substantial to perfect agreement (see Landis & Koch, 1977) with Kappa scores ranging from $\kappa = 0.61$ to $\kappa = 1.00$. Only regarding two codes did the agreement between the two raters reach unsatisfactory Kappa scores below $\kappa < 0.61$. However, both the first and the second rater coded the full data set and all disagreements were resolved by discussion and by joint re-reading and analysis of the respective studies.

training, and others). We additionally extracted the following information: name of authors, year of publication, total sample size, specific type of participants (e.g., 3rd graders, college students), and the country where the study took place.

The two raters further coded whether the authenticity of the learning settings was achieved through the following eight *design elements*: (1) collaboration, (2) complex problem/task, (3) inquiry/investigation, (4) experts/practitioners, (5) real-life/professional setting, (6) real-life materials/cultural tools, (7) authentic assessment, and (8) technology. Table 4 provides the codes used to analyze the design elements implemented in the studies.

The authenticity of the design elements was analyzed for two learning settings per study: the authentic learning setting (experimental condition) and the less or non-authentic learning setting (control condition). Three of the 50 studies compared more than two learning settings by implementing multiple authentically designed learning settings or multiple control conditions that only differed minimally with respect to their design elements. As these minimal differences would not have led to different coding results, we viewed these conditions as a single unit.

The two raters additionally coded the *intentions of authenticity* underlying the design of the authentic learning settings. Specifically, they coded whether the design aimed to (1) create personally meaningful learning, (2) emulate the work of professionals, (3) connect learners with a community of practitioners, and/or (4) reflect experiences from everyday life. Table 5 shows the respective codebook.

Calculation of Effects

The first author and a second rater coded 100% of the studies with respect to whether or not the studies examined cognitive effects (i.e., knowledge, achievement, transfer, problem solving), motivational effects (e.g., intrinsic motivations, interest, satisfaction, self-efficacy), and effects on students' perceived authenticity. The interrater reliability analysis showed satisfactory agreement between the two raters for the three effect-related codes, with the following Kappa scores: 1.00 (examination of cognitive effects), 0.88 (examination of motivational effects), and 0.79 (examination of perceived authenticity). Disagreements were again resolved by discussion.

To compare the effects between the studies, we used Cohen's *d*. If the studies did not report Cohen's *d*, we used other effect sizes (e.g., η^2), test statistics (e.g., *z*, *t*, or *F* values), or the reported means and standard deviations in order to calculate Cohen's *d*. If multiple cognitive or motivational effects were examined in a single study or if a study involved multiple comparisons incorporating more than two conditions, we calculated the mean score of the different effect sizes.²

² We are aware of the limitations of this procedure but believe that it is the most suitable solution for our purpose. We would not know how to justify the selection of only one effect size per study. Including the respective studies multiple times would ignore the dependency of the effect sizes. Moreover, our data do not fulfill the prerequisites for conducting a multilevel (correlations between effect sizes are unknown) or three-level (not every study reports at least four effect sizes) meta-analysis (see Cheung, 2019). Against this background and as our purpose is not to conduct a traditional meta-analysis and to calculate the "true" effect size of authentic learning, we think that averaging the effect sizes is appropriate for our purpose, i.e., conducting contrasting-cases analyses.

Table 4 Codebook “design elements”

Code	Definition based on different operationalizations of authenticity	Examples in studies included in the present review
Collaboration	Relates to the “social setting” (Betz et al., 2016) of an authentic learning environment and is fostered by “tasks that are addressed to group rather than individual” and by a “classroom organization into pairs or small groups” (Herrington & Oliver, 2000, p. 30). Collaboration in authentic learning settings can either take place among learners only or among learners and practitioners (Hod & Sagy, 2019)	6th graders collaboratively complete different gaming tasks in a unit on biology and environmental science (Chen & Hwang, 2017)
Complex problem/task	“Authentic learning involves problems rooted in the real world” (Rule, 2006, p. 2). These problems or tasks should be ill-structured and complex (Herrington & Oliver, 2000), and relate to “themes from the respective ‘real’ reference context” (Betz et al., p. 817)	Students are asked to act as junior advisors of a consultancy agency and to write a report on both the reasons why the employees of a bus company are often sick and strategies to reduce this high sickness rate (Gulikers et al., 2005)
Inquiry/investigation	Authentic activities foresee “a sustained period of time for investigation”, provide “an opportunity for students to define the tasks” and “to detect relevant information” (Herrington & Oliver, 2000, p. 30). Authentic learning occurs through “discovery, inquiry and induction” (Rule, 2006, p. 3) and may be achieved by “inquiry- or task-based learning” (Betz et al., 2016, p.817)	10th graders in a physics course examined different pulley systems and tested the reliability of their own calculations related to the mechanical procedures of the pulleys (Samsudin et al., 2020)
Experts/practitioners	Authentic learning provides “access to expert performances” (Herrington & Oliver, 2000, p. 30) and “provides students with opportunities for direct interaction with practitioners of the culture” (Hod & Sagy, 2019, p. 146)	In a course on instructional design, students receive input from an instructional designer from a local company (Zheng, 2010)
Real-life/professional setting	An authentic “learning location [...] permits insights into the work of ‘communities of practitioners’” (Betz et al., 2016, p.817). Thus, authentic learning may take place “in the context of the professional or expert setting” (Hod & Sagy, 2019, p. 146) or in “a physical environment” that “reflects the way the knowledge will be used in real life” (Herrington & Oliver, 2000, p. 30)	To learn about aquaponics, learners visit an agritourism farm (García et al., 2020) High school students visit an out-of-school lab for biotechnology located at a university (Röllke et al., 2020)

Table 4 (continued)

Code	Definition based on different operationalizations of authenticity	Examples in studies included in the present review
Real-life materials/cultural tools	In an authentic learning setting, learners have access to the cultural tools of a professional community (Hod & Sagi, 2019) or to materials that enable an “approach to the everyday or professional world” (Betz et al., 2016, p. 817)	Students watch episodes of a Spanish-language telenovela in order to improve their language skills in Spanish (Weyers, 1999)
Authentic assessment	An authentic assessment should be “seamlessly integrated with the activity” and thus have a high fidelity to the context of learning (Herrington & Oliver, 2000, p. 31). Authentic assessments may be “complex, ill-structured challenges” or may ask learners “to craft polished performances or products” (Herrington & Oliver, 2000, p. 31)	During a French language learning class, students listen to an unedited radio program produced in France in order to improve their listening comprehension. In the final assessment, students again listen to native French speakers in an unedited videotape and then answer questions (Herron & Seay, 1991)
Technology	Relates to learning settings that are technology-mediated/computer-supported in order to implement authenticity	In a ubiquitous learning environment, students have access to a 360° virtual laboratory using a tablet (Virtanen et al., 2017)

Table 5 Codebook “intentions of authenticity”

Code	Definition based on different conceptualizations of authenticity	Examples in studies included in the present review
Personally meaningful	To be personally meaningful, learning settings, “should challenge and empower students to exceed personal limits, as well as make a demonstrable difference in students’ lives” (Shaffer & Resnick, 1999, p. 199). In these settings, learners are enabled to “produce knowledge with value in students’ lives and studies beyond simply proving their competence” (Strobel et al., 2013, p. 147). The goal is that learners develop “feelings of ownership over and agency within projects” (Polman et al., 2018, p. 1670)	To learn about energy saving, 5 th graders conduct interviews with their parents and neighbors, analyze buildings on their school campus, and build their own energy-saving house (Lee et al., 2013). ^a In a course on curriculum development, teacher candidates conduct interviews with professional teachers, and analyze current curricula with respect to different strengths and weaknesses (Hursen, 2016). ^a
Work of professionals	This kind of authenticity “locates the real in the data, tools, and operations of the disciplines represented as school subjects in the curriculum” (Doyle, 2000, p. 3). Learners should work “with the materials and problems that real subject specialists have done or easily might do as part of their professional lives” (Doyle, 2000, p. 3). Thus, learners “should learn history by making history for themselves like professional historians, or tackle engaging and interesting questions of mathematics in the same way that mathematicians do” (Shaffer & Resnick, 1999, p. 199)	Nurse-college students analyze cases about nurse-patient communication with respect to situations causing miscommunication (Yoo & Park, 2015). ^b Undergraduate students conduct radioactivity experiments by remotely using a Geiger counter as part of the actual equipment of a real laboratory (Sauter et al., 2013)
Community of practice	Based on this intention of authenticity, “learning involves enculturation into [...] communities [of practitioners] (Doyle, 2000, p. 5). For this purpose, “students must enter into a community in which the concepts are used and acquire the community’s culture by engaging in authentic activity (that is, the ordinary practices of the culture)” (Doyle, 2000, p. 5). To connect learners with a wider community of practitioners outside their classroom, they may “develop products for authentic audiences” (Polman et al., 2018, p. 1670)	Teacher candidates are connected to professional learning communities and are supervised by experienced teachers (Chizhik et al., 2017). ^c College students work on client-based STEM projects and interact with the clients (from medicine, industry, etc.) several times during the course (Beier et al., 2019). ^d

Table 5 (continued)

Code	Definition based on different conceptualizations of authenticity	Examples in studies included in the present review
Everyday experiences	To resemble everyday experiences, “the materials and activities of the learning environment [should] reflect or recreate some aspect of the world outside of school (or outside of the learning environment more generally)” (Shaffer & Resnick, 1999, p. 198). Thus, the learning setting should “resemble challenges or social interactions in daily life”, “bring real world experience to the classroom, and mirror “situation[s] similar to ‘in-the-wild’” (Strobel et al., 2013, p. 147)	7 th graders analyze real research studies found in magazines and pamphlets in order to reflect on the topic of cause-and-effect relationships (Hendricks, 2001) 5 th graders interact with “original objects” (i.e., living mice) that have “a close connection to everyday life” in a biology lesson (Wilde et al., 2012)

^aOverlap between PERSONALLY MEANINGFUL and REAL-LIFE EXPERIENCES

^bOverlap between WORK OF PROFESSIONALS and PERSONALLY MEANINGFUL

^cOverlap between COMMUNITY OF PRACTICE and PERSONALLY MEANINGFUL

^dOverlap between COMMUNITY OF PRACTICE and WORK OF PROFESSIONALS

Results

Before investigating our research questions, we describe the context of the studies, such as the learning domains and the participants. We then analyze the implemented design elements of the learning settings and their underlying intentions of authenticity (Research Question 1). Next, we analyze the *cognitive effects* and compare and contrast studies revealing beneficial effects with those showing small, no, or even negative cognitive effects in order to identify potential design elements and intentions of authenticity of effective authentic learning settings (Research Question 2). We then describe the investigated *motivational effects* and again conduct a contrasting-cases analysis of the studies revealing high effectiveness versus those revealing low effectiveness of authentic learning for motivational learning outcomes (Research Question 3). Finally, we describe the studies that investigated students' perceived authenticity (Research Question 4).

Context of the Studies

As can be seen in Table 6, most of the studies examined the effectiveness of authentic learning in school students. Moreover, the effectiveness of authentically designed learning settings was particularly tested for learning in STEM domains. The studies usually incorporated a quasi-experimental design with two conditions, implemented multiple training or learning sessions, and had a sufficient sample size for conducting inferential statistics. Further, the studies took place in various countries on five different continents, favoring the Asian continent. An overview of the context information per study can be found in the supplementary material (see Online Resource 1).

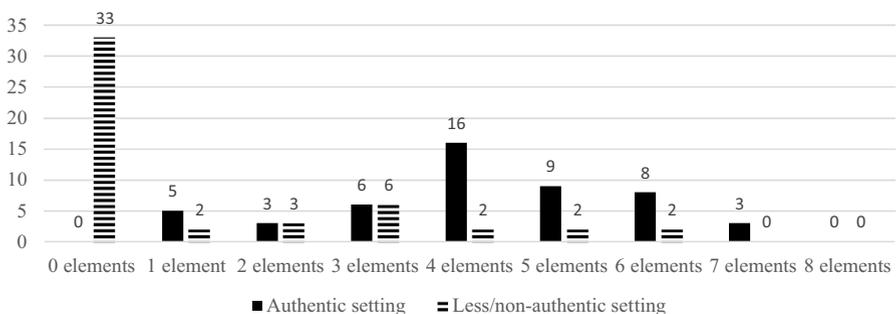
Research Question 1: Design Elements and Intentions of Authenticity

Design Elements of the Learning Settings

Most of the authentic learning settings ($n = 36$) implemented and tested in the studies can be characterized by more than four authentic design elements (see Fig. 3). As Fig. 3 shows, none of the learning settings included all eight design elements. The majority of the studies tried to achieve authenticity by implementing the design element of inquiry/investigation (see Fig. 4) through, for instance, problem-based, project-based, or case-based learning activities. The activities often also included the use of authentic learning materials (i.e., real-life materials or cultural tools), complex problems/tasks, and collaboration between learners. Figure 4 further shows that many studies implemented technology-supported learning environments in order to design for authenticity. Achieving authenticity by learning in a real-life or professional setting and/or with an expert or practitioner plays no prominent role in the studies on authentic learning included in the present review (see Fig. 4), and authentic assessments are even less relevant for designing authentic learning settings.

Table 6 Descriptive statistics on the context of the studies

Category	Subcategories	Number of studies
Participants	Primary school students (i.e., 3rd to 6th graders)	15
	Secondary school students (i.e., 7th grade and higher)	12
	Undergraduate students	10
	University/graduate/higher education students	4
	Student teachers	3
	Nursing students	2
	Business school students, vocational college students, employees, others/volunteers	1 (each)
Learning domains	STEM	21
	Language	10
	Social Sciences and Humanities	9
	Vocational training	8
	Others	2
Study designs	Quasi-experiment with two conditions	33
	Experiment with two conditions	14
	Quasi-experiment with three conditions	2
	Experiment with four conditions	1
Duration of treatments	Multiple training sessions	40
	Single training session	10
Sample size	> 30 per condition	36
	< 30 per condition	14
Countries	Taiwan	14
	USA	11
	Turkey	5
	Indonesia, Netherlands	3 (each)
	Germany, China/Hong Kong, Iran	2 (each)
	Finland, Canada, Colombia, Cyprus, Egypt, India, Malaysia, South Korea	1 (each)

**Fig. 3** Number of authentic design elements implemented in the authentic (experimental condition) and less or non-authentic (control condition) learning settings. The y-axis relates to the number of studies

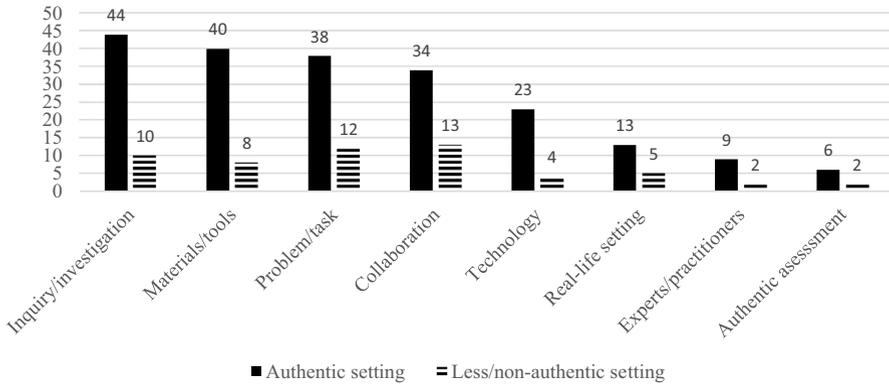


Fig. 4 Types of authentic design elements implemented in the authentic (experimental condition) and less or non-authentic (control condition) learning settings. The y-axis shows the number of studies

The majority of the studies ($n=39$) compared the authentic learning settings to conventional teacher-led learning methods, such as lecture-based learning. It should be noted that these studies often include no detailed descriptions of the conventional methods implemented in the control conditions. In such cases, we coded the conventional/traditional learning settings as being non-authentic, meaning that they incorporate none of the eight authentic design elements. In 33 studies, the conventional learning methods incorporated none of the authentic design elements (see Fig. 3).

Intentions of Authenticity

Table 7 shows the number of studies that followed either one of the four intentions of authenticity or a combination of different intentions of authenticity in order to design authentic learning settings. It should be mentioned that the majority of the studies did not explicitly define the term of authentic learning or specifically describe the kind(s) of authenticity implemented in the respective learning settings. Hence, the results presented here build on our coding of the descriptions of the study method given in the papers.

As can be seen, the majority of the 50 studies implemented learning settings that tried to connect the learning activities with experiences from real life in order to create authenticity. In seven studies, authenticity was solely approached through emulating the work of professionals in a certain domain. One study combined the two intentions of reflecting real-life experiences and emulating the work of professionals. The intentions of creating personally meaningful learning and of connecting learners to a community of practitioners were only implemented in combination with the other intentions of authenticity or, in one study, in combination with each other. Only one study pursued three different intentions of authenticity, namely real-life experiences, work of professionals, and community of practice. None of the

Table 7 Intentions of authenticity proposed by the 50 studies

	Real-life experiences	Work of professionals	Personally meaningful	Community of practice	Number of studies
✓					25
		✓			7
✓			✓		4
		✓	✓		3
		✓		✓	2
✓	✓				1
			✓	✓	1
✓	✓			✓	1
✗	✗		✗	✗	6

studies included in our review combined all four intentions in order to design for authenticity.

The learning settings of six studies did not fit any of the four intentions of authenticity. Specifically, Kurniawan et al. (2020) and She and Lee (2008) tested learning settings that build on the Dual Situated Learning Model, according to which learning should be situated in the context of both the critical features of a targeted learning concept and students' (mis)conceptions about the respective learning concept. *Situated learning* as achieved in these two studies aims at fostering students' conceptual change and does not focus on demonstrating the real-world relevance and functionality of a certain learning concept to students. Consequently, these two studies could not be classified into any of the four intentions of authenticity discussed here. Chang et al. (2020) and Tsai et al. (2020) implemented game-based learning in order to create authenticity, but the games provided a rather simplified or even fictitious cover story, meaning that the learning experiences were not situated in complex real-world scenarios. Moreover, the learning activities implemented in the games were rather structured and appeared to be less engaging. Consequently, we did not see a fit to one of the four intentions of authenticity for these two studies. The study conducted by Martin and Ertzberger (2013) compared learning in art classes between students who viewed paintings while having direct access to information about the paintings through mobile technology (which the authors described as an authentic setting) and students who first viewed the paintings and then had to go back to the classroom to read about the paintings on a computer. However, this understanding of authenticity in terms of when and where information is provided does not fit one of the four intentions of authenticity described in the present paper. The sixth study conducted by Sharma (2016) gave a rather vague description of the method, such that we were unable to identify the underlying intention(s) of authenticity.

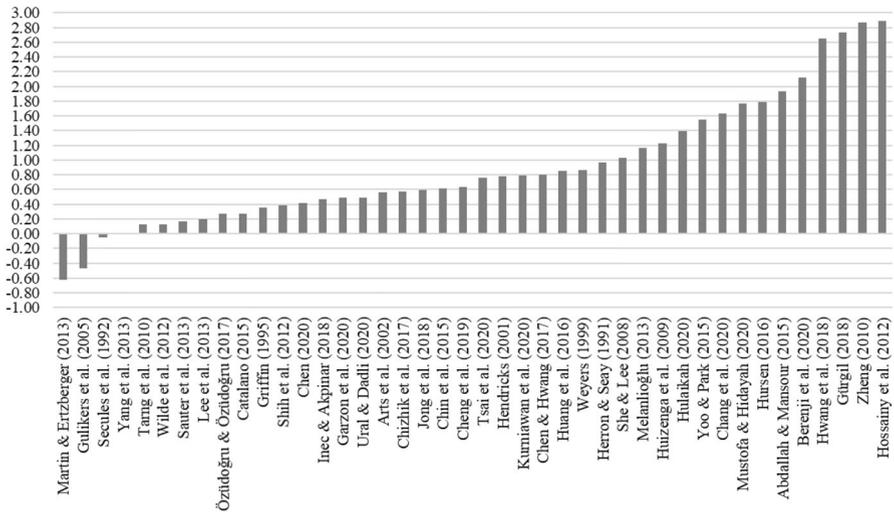


Fig. 5 Distribution of cognitive effects revealed by 42 studies

Research Question 2: Cognitive Effects

Descriptive Analysis

Forty-two of the 50 studies investigated the cognitive effects of authentic learning. What we describe as *cognitive effects* relates to several different variables. The majority of the studies included in our literature review investigated the following cognitive effects of authentic learning: knowledge acquisition, achievement, or performance. Studies on authentic language learning examined the effectiveness of authentically designed learning settings on writing, reading, listening, and/or communication skills. Further cognitive effects refer, for instance, to learners' problem-solving ability, thinking and reasoning skills, teaching skills, or scientific competencies.

Figure 5 shows the distribution of cognitive effects. The majority of the studies ($n=18$) demonstrated large cognitive effects (i.e., $d \geq 0.8$) of authentic learning settings. Eight studies showed moderate effects (i.e., $0.5 \leq d < 0.8$), nine studies demonstrated small effects (i.e., $0.2 \geq d < 0.5$), and seven studies revealed no (i.e., $0 \geq d < 0.2$) or even negative effects (i.e., $d < 0$).

Contrasting-Cases Analysis

For the contrasting-cases analysis, we compared the 26 studies that demonstrated moderate or large effects of authentically designed learning settings on cognitive learning outcomes (henceforth referred to as HE [high effectiveness] studies) with the 16 studies that demonstrated small, no, or negative effects (henceforth referred to as LE [low effectiveness] studies) in terms of the four intentions of authenticity and the eight design elements of the implemented authentic learning

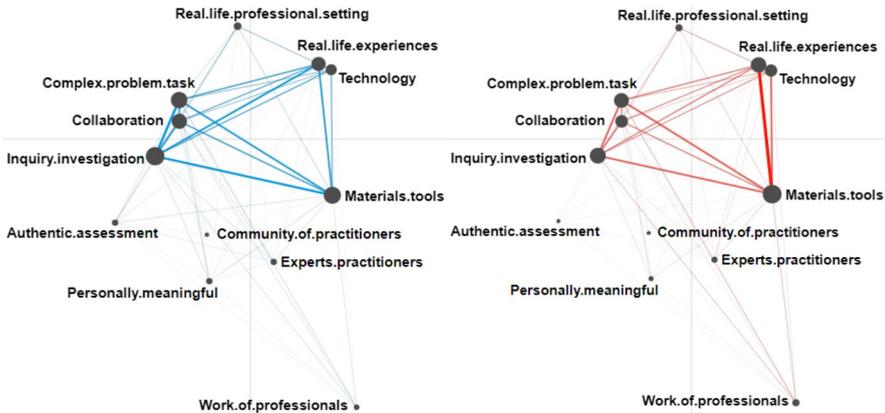


Fig. 6 Mean ENA network diagrams showing the connections between the design elements and intentions of authenticity of HE studies (blue network, left) and LE studies (red network, right) investigating cognitive effects

setting. First, we constructed mean epistemic networks for each set of studies. As these mean networks depicted in Fig. 6 show, the authentic learning settings implemented and tested in both HE studies (blue network, left) and LE studies (red network, right) make dense networks of connections between the following design elements (note, the darker and thicker the line, the stronger the connection/co-occurrence of certain design elements and/or intentions of authenticity in the studies): INQUIRY/INVESTIGATION, MATERIALS/TOOLS, TECHNOLOGY, COMPLEX PROBLEM/TASK, and COLLABORATION. In addition, these design elements are linked to the goal of simulating REAL-LIFE EXPERIENCES in both HE and LE studies. However, LE studies also link these design elements more strongly than HE studies to the goal of emulating the WORK OF PROFESSIONALS.

By subtracting the networks (Fig. 7), the differences between the HE and LE studies become clearer. Note that darker and thicker lines illustrate larger differences in the strength of connections and that the color of the lines indicates in which network the connections are stronger. As Fig. 7 shows, compared to LE studies, the HE studies (blue) make slightly more links between AUTHENTIC ASSESSMENT and COLLABORATION. That is, five out of 26 HE studies implemented authentic assessments and collaborative learning activities in their authentic learning settings, while none of the LE studies combined these two features. Compared to HE studies, LE studies make slightly more connections between MATERIALS/TOOLS and TECHNOLOGY. Specifically, while 50% of the LE studies (i.e., eight out of 16 studies) use both materials and technology in order to design for authenticity, only 42% of the HE studies do so (i.e., 11 out of 26 studies). Furthermore, while HE studies link the authenticity intention REAL-LIFE EXPERIENCES more strongly to the design element INQUIRY/INVESTIGATION (i.e., 16 out of 26 (62%) HE studies vs. 8 out of 16 (50%) LE studies), LE studies (red) link this intention of authenticity more

Fig. 7 ENA difference graph for the coded features in HE (blue) and LE (red) studies (cognitive effects)

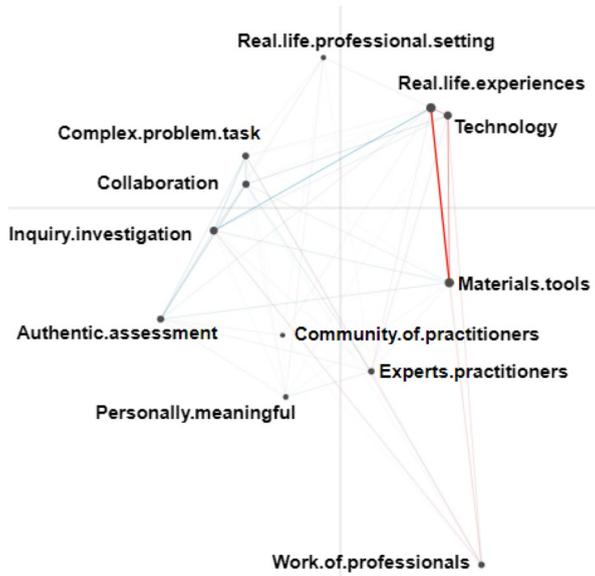
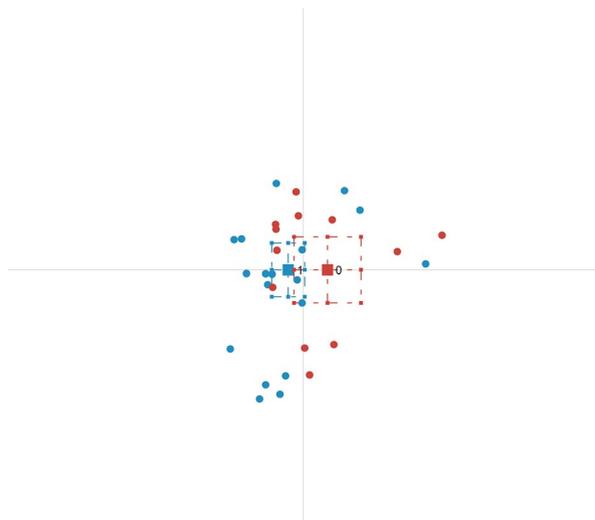


Fig. 8 ENA scatter plot showing HE (blue) and LE (red) studies (cognitive effects)



strongly to MATERIALS/TOOLS (i.e., 12 out of 16 (75%) LE studies vs. 14 out of 26 (54%) HE studies).

Figure 8 shows the network location of each study, along with the means and 95% confidence intervals of HE (blue) and LE studies (red). It is evident that HE and LE studies differ from each other regarding their implemented design

elements and intentions of authenticity, as the two confidence intervals overlap only slightly.

These differences are supported by a *t*-test revealing a statistically significant difference between HE and LE studies on the first (*x*) dimension with a moderate effect ($M_{HE} = -0.23$, $M_{LE} = 0.38$; $t = -2.23$, $p = 0.04$, Cohen's $d = 0.78$).

In summary, our ENA results suggest that resembling real-life experiences by using authentic real-life materials or cultural tools of practitioners may harm the effectiveness of authenticity for cognitive learning outcomes. The picture is less clear regarding highly effective learning settings, although HE studies implemented a combination of collaborative learning activities and authentic assessments more often than did LE studies. In fact, only six studies implemented authentic assessments at all, and five of these demonstrated a high effectiveness of authentic learning. Moreover, compared to LE studies, HE studies combined inquiry-based learning activities with the goal of resembling real-life experiences slightly more often.

Research Question 3: Motivational Effects

Descriptive Analysis

Twenty-seven of the 50 studies investigated different motivational effects of authentic learning, often relating to the following outcome variables: attitudes (towards the learning setting or domain), (intrinsic, extrinsic, academic, or learning) motivation, self-efficacy, or satisfaction. A small number of studies also focused on variables such as situational interest, engagement, flow, or utility value.

Figure 10 shows the effect sizes regarding the motivational and emotional learning outcomes in 25 studies. In two studies, by Huizenga et al. (2009) and Martin and Ertzberger (2013), the reported data were only sufficient for calculating the cognitive effects but not for the effects on motivational outcomes. Of the 25 studies reporting sufficient data, 10 studies revealed large motivational effects of authentic learning and five studies each demonstrated moderate, small, and no or negative effects (see Fig. 9).

Contrasting-Cases Analysis

With respect to the motivational effects, we compared the 15 studies that demonstrated moderate or large effects (again summarized as HE studies) with the 10 studies that demonstrated small, no, or negative effects of authentically designed learning settings (again summarized as LE studies) on motivational learning outcomes. Once again, we compared the studies regarding the four intentions of authenticity and the eight design elements of the implemented authentic learning setting. The mean ENA networks are depicted in Fig. 10.

As these mean networks show, both LE studies (red network, top) and HE studies (blue network, bottom) make dense networks of connections between the following design elements: INQUIRY/INVESTIGATION, COLLABORATION, and COMPLEX PROBLEM/

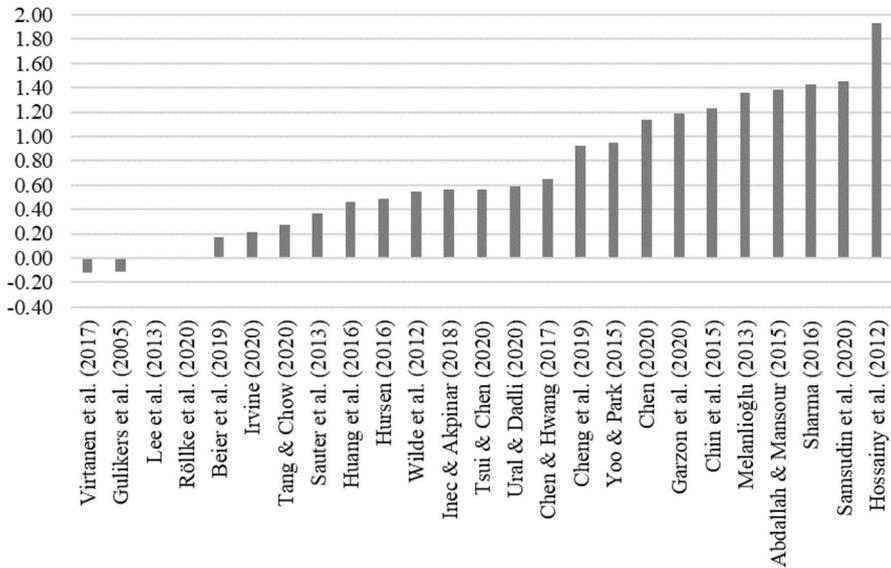


Fig. 9 Distribution of motivational effects revealed by 25 studies

TASK. In HE studies, these features are further strongly linked to MATERIALS/TOOLS and TECHNOLOGY. While HE studies link their authentic design elements more strongly to the goal of resembling REAL-LIFE EXPERIENCES, LE studies make a stronger link to the goal of emulating the WORK OF PROFESSIONALS.

The difference graph in Fig. 11 illustrates that the design elements TECHNOLOGY, MATERIALS/TOOLS, and COMPLEX PROBLEM/TASK are more strongly linked to the goal of resembling REAL-LIFE EXPERIENCES in the network of HE studies (blue) than in LE studies. By contrast, LE studies (red) link the design elements COMPLEX PROBLEM/TASK, MATERIALS/TOOLS, and COLLABORATION more strongly to the goal of emulating the WORK OF PROFESSIONALS than do HE studies. The most critical difference is that HE studies use authentic MATERIALS/TOOLS in order to resemble REAL-LIFE EXPERIENCES more often than do LE studies (10/15 studies; 67% vs. 2/10 studies; 20%), while LE studies use COMPLEX PROBLEMS/TASKS for emulating the WORK OF PROFESSIONALS more often than do HE studies (6/10 studies; 60% vs. 3/15 studies; 20%).

Figure 12 illustrates the ENA results in a scatter plot, which clearly supports the previously described differences between HE and LE studies, as the two confidence intervals do not overlap. A *t*-test again reveals a statistically significant difference between LE (red) and HE (blue) studies on the first (*x*) dimension with a large effect ($M_{HE} = -0.39$, $M_{LE} = 0.59$; $t = -4.44$, $p < 0.01$, Cohen's $d = 1.65$).

In summary, our ENA results suggest that resembling real-life experiences by using authentic real-life materials or cultural tools of practitioners may foster the effectiveness of authenticity for motivational learning outcomes. By contrast, asking students to solve a complex problem or task in order to emulate the work of professionals may harm the effectiveness of authentically designed learning settings for motivational outcomes.

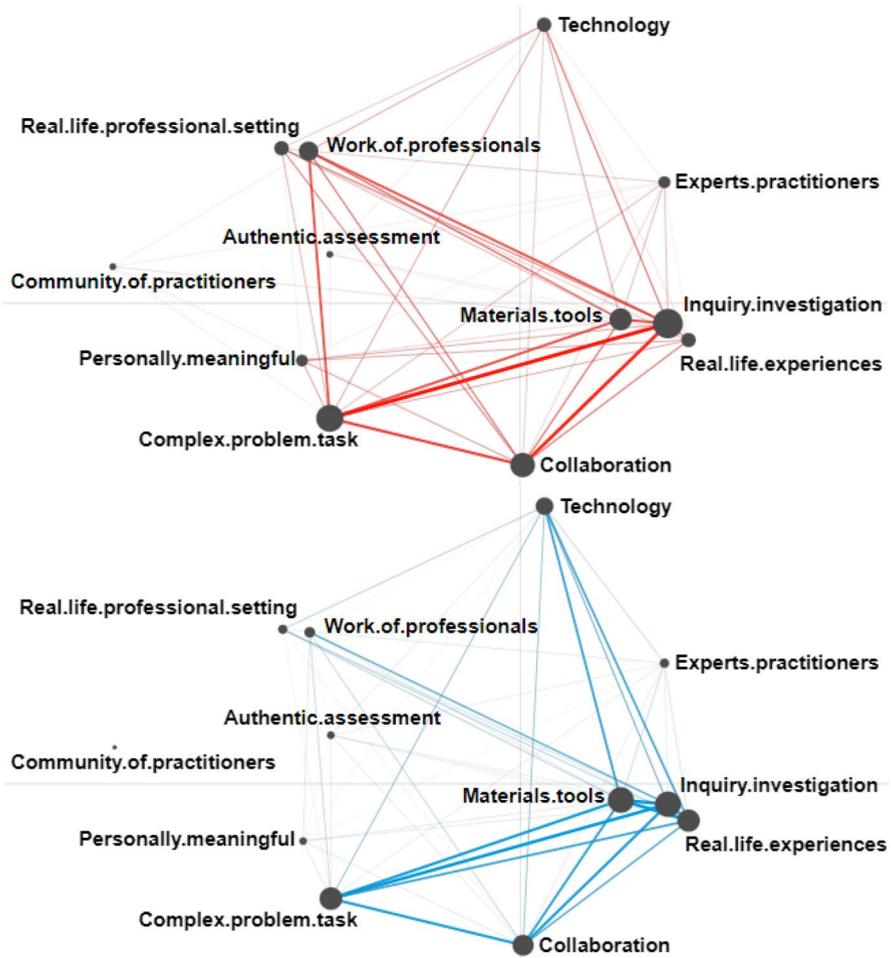


Fig. 10 Mean ENA network diagrams showing the connections between the design elements and intentions of LE studies (red network, top) and HE studies (blue network, bottom) investigating motivational effects

Research Question 4: Perceived Authenticity

Only two studies included in our review, namely by Gulikers et al. (2005) and Sauter et al. (2013), took learners' *perceived authenticity* into account. These studies revealed small effects of authentically designed learning settings on learners' perceptions of the realism of a radioactivity lab ($d=0.44$) in the study by Sauter et al. (2013) and on students' perceived authenticity of the learning environment ($d=0.32$) in the study by Gulikers et al. (2005).

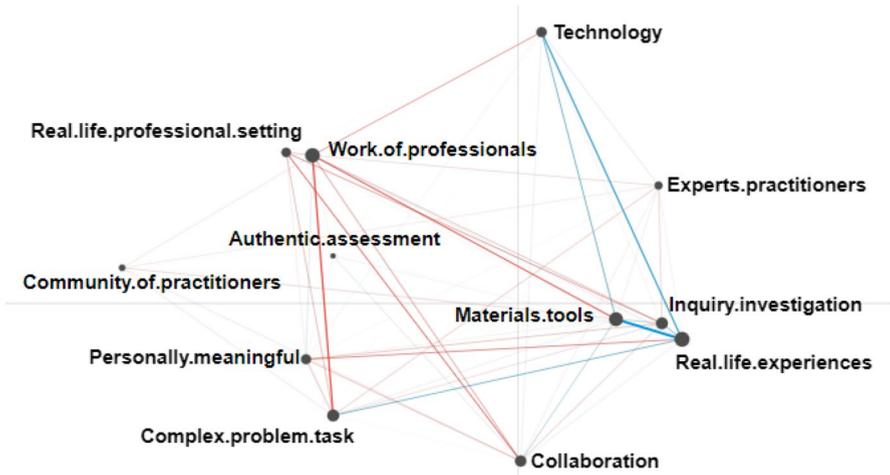
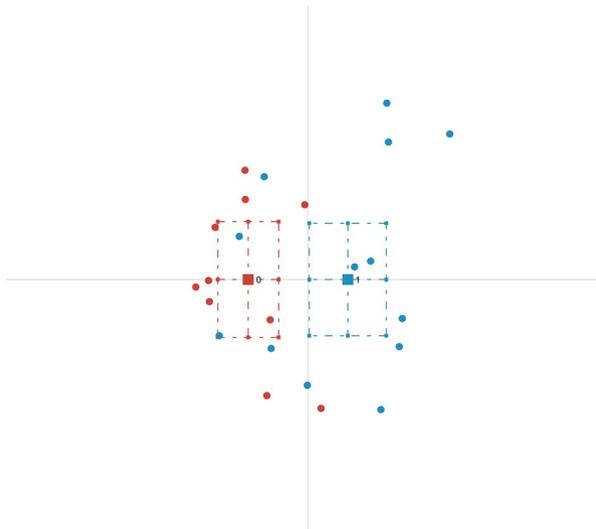


Fig. 11 ENA difference graph for the coded features of LE (red) and HE (blue) studies (motivational effects)

Fig. 12 ENA scatter plot showing LE (red) and HE (blue) studies (motivational effects)



Discussion

There is nowadays a large body of research on authentic learning. It is suggested that authentically contextualized learning experiences foster a wide range of learning outcomes (see Fig. 1). However, while several literature reviews have been conducted to specify and conceptualize the term of authentic learning (see Table 1), no previous

attempts have been undertaken to systematically analyze and organize the broad research on authentic learning with respect to the demonstrated effects, the implemented design elements, and the underlying intentions of authentically designed learning settings. To address this gap, the present literature review described and analyzed 50 studies on the effectiveness of authentic learning with regard to these three factors, along with the context of the studies. Additionally, we sought to identify design elements and intentions of authenticity that may relate to the effectiveness of authentic learning.

With regard to the *context of the studies* (see Table 6), our findings show that research on the effectiveness of authentic learning is internationally widespread. Furthermore, this field of research is highly diverse, with studies investigating different domains (favoring STEM domains) and different populations (favoring school students).

In our analysis of the *design elements* used for creating authentic learning settings, we identified that inquiry-based learning activities are commonly implemented, which also provide students with authentic materials and ask students to collaboratively tackle a complex problem. Less common are authentic assessments, interactions with experts or practitioners, and visits to real-life or professional settings. Moreover, the authentically designed learning settings are usually compared with settings that incorporate traditional or conventional instructional methods, such as lecture-based learning. However, it should be mentioned that many studies included in the present review did not provide a detailed description of the design of their less or non-authentic learning setting implemented in the control condition. Moreover, the majority of the studies did not give a clear and detailed overview of the specific design elements used for creating their authentic learning settings. Thus, when coding the studies, it was difficult to extract the information on the design elements of the learning settings.

Regarding the *intentions of authenticity*, our coding shows that the majority of studies pursue the goal of resembling real-life experiences, followed by the goal of emulating the work of professionals. Creating a community of practice is of least interest, which, along with the goal of engaging learners in personally meaningful activities, is only achieved in combination with one of the other intentions of authenticity. Only one study attempted to achieve three different intentions of authenticity, and none of the studies combined all four intentions. Thus, research on authentic learning has not yet focused on designing for and investigating the effectiveness of *thick authenticity* (Shaffer & Resnick, 1999). Again, extracting the information on the intentions of authenticity when coding the studies was difficult, as most studies only provided implicit descriptions of the intention(s) of authenticity underlying their design of an authentic learning setting.

Our findings on the *effects* of authentic learning reveal that the majority of studies included in the present review demonstrated moderate to large effects of authentically designed learning settings on both cognitive and motivational learning outcomes. However, despite focusing on a wide range of cognitive and motivational effects, previous research has not focused on the effects of authentically contextualized learning settings on learners' *perceived authenticity*. Only two studies included in the present review assessed learners' perceived authenticity.

To identify *design elements and intentions of authenticity in the studies demonstrating high effectiveness of authentic learning* versus those with low effectiveness, we conducted ENA of contrasting cases. Studies reporting beneficial effects of authentically designed learning settings on *motivational* learning outcomes were particularly characterized by a combination of providing authentic learning materials and the intention of resembling real-life experiences. At the same time, however, this combination was also found in the studies that showed low effectiveness of authentic learning settings for *cognitive* outcomes. The studies that revealed less beneficial effects on *motivational* outcomes are marked by the use of complex problems and the goal of emulating the work of professionals. Our ENA revealed no clear-cut design elements or intentions of authenticity with respect to advantageous effects of authentic learning on *cognitive* outcomes, as HE (high effectiveness) studies combined authentic assessments and collaborative learning activities only slightly more often than LE (low effectiveness) studies. Additionally, HE studies combined inquiry-based learning activities with the goal of resembling real-life experiences slightly more often than LE studies.

However, in line with Polman,³ the present review demonstrates that authenticity appears to be a “secret sauce” when it comes to designing promising learning settings, with *secrecy* being reflected in the fact that many studies investigating the effects of authentic learning only implicitly describe their definition and operationalization of authenticity. Moreover, many scholars appear not to disclose how their participants perceive the implemented authenticity and sometimes fail to divulge how this authenticity affects certain learning outcomes. Therefore, for future investigations, it appears necessary for researchers to share their “recipes,” and ideally also agree on certain basic ingredients and procedures, which we describe in the following sections.

Secret #1: A Pot to Fill

While coding the studies, we found that most provided no explicit definition of the intention of authenticity underlying the implemented learning setting. Given the numerous classifications of authenticity (see Table 1), it is surprising that the term of authentic learning is still—as Shaffer and Resnick stated two decades ago—“applied loosely and inconsistently” (Shaffer & Resnick, 1999, p. 195). It is further surprising that six studies included in our review implemented authenticity in a way that fits none of the four intentions of authenticity described in different conceptualizations. Thus, the term authentic learning risks being an *empty phrase*. To address this risk, we hope that our synthesis of different conceptualizations of intentions of authenticity (see Table 3) may serve as an orientation for future studies to describe the specific intention (or intentions) pursued by implementing authenticity in a learning context.

³ J. L. Polman, personal communication during his talk “Unpacking the role of authenticity in project-based learning environments” at the Ruhr-University Bochum, May 16, 2019.

Secret #2: The Ingredients

Moreover, the majority of the studies included in the present review did not provide a detailed description of the specific elements that were used to design for authenticity. Again, we hope that our description of common design elements of authentic learning settings (see Table 2) may serve as a taxonomy for future studies to describe the *ingredients* for designing an authentic learning setting. A good example can be found in the study by Gulikers et al. (2005), who refer to Herrington's and Oliver's (2000) nine design elements for describing their implemented authentic learning setting.

Furthermore, future studies on authentic learning should give a detailed description of the design elements of their less authentic or non-authentic learning setting implemented in the control condition. Otherwise, the differences between the implemented learning settings—and thus the specific reasons for the effects of authentically designed learning settings—remain unclear. Additionally, our review revealed that the majority of studies compared two learning settings that differed with respect to more than one design element, as they usually compared a highly authentic learning setting with a traditional/conventional teacher-led approach (see Fig. 3). Hence, there is a need for studies that systematically investigate the effectiveness of authentic learning by varying only one design element at a time. Otherwise, the mechanisms underlying the effectiveness of authentic learning and the conditions for its effectiveness remain undetected.

Secret #3: The Taste

Only two studies included in our review investigated learners' perceived authenticity of the learning setting. As introduced above, perceived authenticity may differ between the designers of a learning setting on the one hand and the users of it on the other hand (Barab et al., 2000). In other words, “authenticity is in the eye of the beholder” (Gulikers et al., 2008) or a *matter of taste*. Consequently, ignoring learners' perceived authenticity may render it difficult to determine whether beneficial effects of authentically designed learning environments indeed emerge due to the intended authenticity or due to other features of the learning setting, such as the novelty of the learning environment and learners' work with exciting technology. Hence, to investigate whether authentically designed learning settings affect learners' motivational and cognitive learning outcomes, it appears necessary to assess learners' perceived authenticity of the learning environment. For instance, one might examine the relation between learners' perceived authenticity and different targeted learning outcomes. To date, however, evidence is lacking on whether authentically designed learning settings have an impact on learners' perceived authenticity and, in turn, whether learners' perceived authenticity affects cognitive or motivational outcomes.

Studies on the effectiveness of out-of-school labs may provide some orientation and inspiration in this regard. Out-of-school labs are non-formal learning settings

that aim to foster students' knowledge about and interest in scientific ways of thinking and working by engaging them in scientifically authentic learning activities (e.g., Scharfenberg & Bogner, 2014). In Germany, research on out-of-school labs has started to focus on investigating students' perceived authenticity of this learning environment and its relation especially to students' interest in the targeted learning topics (e.g., Glowinski & Bayrhuber, 2011). Currently, Wirth and Colleagues are developing a questionnaire to assess learners' perceived authenticity of different features of an out-of-school lab (Wirth et al., 2017). The questionnaire builds on the theoretical model of authenticity in teaching and learning contexts developed by Betz and colleagues (Betz et al., 2016), and will help to systematically investigate the role and interplay of different design elements for the effectiveness of authentically contextualized learning settings. However, this questionnaire and the research on out-of-school labs focus on one certain intention of authenticity, namely the extent to which the students perceive, for instance, the provided materials as authentic cultural tools of scientists. Therefore, there is a need to develop questionnaires that assess learners' perceptions of different intentions of authenticity.

Secret #4: The Yield

During our literature search and the coding of the studies, we had to exclude several studies that reported insufficient data for us to calculate the effect sizes. Moreover, some studies included in our review also report insufficient data, especially when their analyses revealed no differences between the implemented learning settings (i.e., no data reported at all) or when they compared more than two conditions (i.e., no data reported on pairwise comparisons). It is further surprising that we had to calculate the effect sizes ourselves in many cases. For future experimental studies on the effectiveness of authentic learning, it should become a standard to report the effect sizes of the experimental manipulation irrespective of whether the analyses revealed the hypothesized effects. Otherwise, the effectiveness *yielded* by authentically designed learning settings remains unclear.

Recipe Ideas for Future Research

Given the aforementioned limitations of the studies analyzed in the present review, and the difficulty of comparing their findings due to their different characteristics, our ENA results need to be interpreted with caution. Specifically, our ENA results only point to factors that may have an impact on the effectiveness of authentic learning, and further research is needed to systematically investigate the role of these factors for the effectiveness of authentically contextualized learning. With this in mind and building on our ENA results, it might be interesting for future research to explore the following three avenues:

- (1) Our ENA results indicate beneficial *motivational* effects of studies that use authentic learning materials and aim at resembling real-life experiences (see Fig. 11). At the same time, reflecting real-life experiences and providing authentic learning materials may harm the effectiveness of authentic learning settings for *cognitive* outcomes (see Fig. 7). Thus, future research needs to replicate these findings.
- (2) According to our findings, it might be fruitful to investigate the role of assessment authenticity for the effectiveness of authentic learning settings. Of six studies that implemented authentic assessments, five found authentically designed learning settings to be highly effective for cognitive outcomes. Moreover, our ENA revealed that these studies also implemented collaborative learning activities (see Fig. 7). However, as the number of studies that implemented authentic assessments is very low in the present review, again, these findings need to be replicated in further research.
- (3) A further interesting line of future research could focus on whether the effectiveness of authentic learning differs depending on the underlying intention of authenticity. Specifically, our ENA results suggest that the studies demonstrating small, no, or even negative *motivational* effects combined different design elements more strongly with the goal of resembling the work of professionals, while the studies that showed moderate and large effects of authentic learning linked certain design elements more strongly to the goal of reflecting real-life experiences (see Fig. 11).

Limitations

A first limitation of the present conceptual literature review may relate to certain inclusion criteria used for our literature search, as in order to standardize our data set and to avoid duplicate publications, we focused on journal papers. To reduce publication bias in systematic reviews and meta-analyses, Dalton et al. (2016) suggest including gray literature, such as conference papers. Thus, future work that is interested in estimating the true effect size of authentically designed learning settings and/or explaining the variation in respective effect sizes (provided that there is sufficient research on authentic learning to conduct a meta-analysis) should focus more strongly on gray literature. In the present review, we focused on systematically determining and describing the diversity in research on authentic learning and on identifying potential design elements and intentions of authenticity of effective authentic learning settings. Furthermore, it should be noted that we did not find any (unpublished) dissertation theses and excluded only four conference papers that met our main inclusion criteria during our rounds of literature search. Moreover, our literature review included articles published in journals with impact factors ranging from 0.21 to 8.54 ($M=3.21$; $SD=1.88$). One could conjecture that (non-significant) small and null effects are more likely to be published in journals with rather small impact factors than in journals with high impact factors (see also Joobar et al., 2012). These (often lesser-known) journals with small impact factors, as well as studies with small, no, or negative effects of

authentic learning (i.e., 16 studies for cognitive effects and 10 studies for motivational effects), were represented in our data set.

A second limitation may result from our focus on experimental and quasi-experimental studies, given our aim to compare and contrast studies demonstrating high and low effectiveness. However, during our literature search, we came across ample interesting research on authentic learning that incorporated rather qualitative research designs. Thus, it may be fruitful for future conceptual literature reviews to include or focus on findings from qualitative research.

A third limitation may relate to the analysis of the most common design elements of authentic learning settings and intentions of authenticity. Specifically, we coded different design elements and intentions of authenticity that have been described in at least two different theoretical frameworks, literature reviews, or operationalizations related to authentic learning. An alternative coding strategy that might be interesting for future reviews could focus on analyzing more exceptional design elements and intentions of authentic learning settings and their role for the effectiveness of authenticity.

Conclusion and Contribution

Authenticity in learning settings has received a great deal of research interest and—as the results of the present review demonstrate—already plays a role in designing learning environments for young children. As it is important to help students recognize the value and functionality of certain learning contexts by means of authentically contextualized learning, it is worthwhile to investigate promising ways to achieve this goal and to identify boundary conditions of the effectiveness of authentically designed learning settings. Based on the findings of the present literature review, we call for greater clarity within the research regarding the conceptualizations of authenticity (i.e., intentions of authenticity underlying the design of an authentic learning setting), the operationalizations of authenticity (i.e., design elements used for creating an authentic learning setting), the design of the studies, and the reporting of findings.

Our literature review not only provides specific orientations to implement such research approaches, but also contributes to educational research on authentic learning in multiple ways: (1) It synthesizes and organizes several classifications and operationalizations of authenticity and contributes to a less diffuse use of authentic learning by distinguishing between *design elements* of authentic learning settings and *intentions of authenticity*. (2) It demonstrates different interplays between certain design elements and/or intentions of authenticity that may evoke differentiated effects on motivational and cognitive learning outcomes. Our ENA results suggest that under certain circumstances, authentically designed learning settings promote motivational learning outcomes while at the same time impeding cognitive learning outcomes. These findings could help to further develop a theoretical model (such as the model suggested by Betz et al., 2016) on the mechanisms and effectiveness of authenticity in learning and teaching contexts. (3) The potentially differentiated effects of authentic learning (which require further research) point to major challenges for the design of effective

authentic learning settings. For instance, teachers and instructional designers may face what we call an authenticity dilemma (which is partly comparable with the assistance dilemma described by Koedinger & Alevan, 2007). As indicated by our literature review, authenticity is usually accompanied by a high level of real-world complexity (e.g., by providing real-life materials) and a rather low level of instructional structure (e.g., by asking learners to independently solve a complex problem). Thus, it might be assumed that to create an effective learning setting for both motivational and cognitive learning outcomes, it is necessary to find a “sweet spot” of authenticity in learning contexts, entailing a balance between real-world complexity and instructional structure (or didactic reduction). (4) Finally, the findings of the present literature review point to critical challenges for investigations into the effectiveness of authentic learning, particularly with regard to how to design a study such that the detected effects can actually be traced back to the *authenticity* of the learning setting. For instance, this issue relates to finding an adequate control condition that is comparable to the authentic learning setting and to finding ways to take learners’ perceived authenticity into account.

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Declarations

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