Inquiry-Based Learning For All:

A Systematic Review of the Effects of Inquiry-Based Learning on Knowledge, Skills,
Attitudes and Behavior of Students with Social-Emotional and Behavioral Difficulties in
Primary and Secondary Education

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Author Note

This research was supported by a grant from the Netherlands Initiative for Education
Research (NRO): 405-18-636.

ABSTRACT

Inquiry-Based Learning (IBL) has internationally been recommended as an effective method to achieve learning goals for students in elementary education. On the condition that students are provided with adequate teacher guidance during IBL, they learn more than students who are taught the same content with explicit instruction. Yet, it is unknown whether IBL is also effective for specific student populations, such as students with social-emotional and behavioral difficulties (SEBD), as these students struggle with skills that are required for IBL. We conducted a systematic review to examine what is known about the use of IBL instructional methods and its adjustments for students with SEBD and whether this instructional method is effective to achieve learning goals with this specific student population. Results showed that IBL is applied for students with SEBD, and that teachers play an important role in making adjustments in terms of teacher guidance and differentiation. IBL instruction is, however, often used and adjusted for students with various disabilities in inclusive classrooms – and not for students with SEBD specifically. Consequently, it is difficult to pinpoint which specific adjustments to IBL instruction are needed for students with SEBD in particular. It seems that the field of IBL for specific student populations is in its infancy. Yet, the available predominantly practice-based research yields sufficient indications to consider IBL instruction as a method to achieve learning goals for students with various social-emotional and academic needs.

Keywords: systematic review, inquiry-based learning (IBL), social-emotional/behavioral difficulties (SEBD), special education, teacher guidance, inclusive education

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Over the past decades, there has been increasing attention for Inquiry-Based Learning (IBL) in educational psychology, especially in the domain of science (e.g., Alfieri, Brooks, Aldrich, & Tenenbaum, 2011; Dobber, Zwart, Tanis, & Van Oers, 2017; Pedaste et al., 2015). IBL is a method in which students are actively involved in their learning process by constructing knowledge about a topic or domain through conducting investigations that loosely follow the stages of the scientific method. That is, students explore a topic in order to get interested in it; they formulate research questions and hypotheses; they plan and execute experiments; they draw conclusions from the collected data; and they present and communicate their findings to others and they engage in reflective activities (Lazonder & Harmsen, 2016; Pedaste et al., 2015). As sharing and debating findings with others is considered vital for deepened conceptual understanding and understanding the ‘nature of science’, almost all inquiry-based learning approaches make use of small group work (Dobber et al., 2017).

By conducting investigations following similar methods and practices as professional scientists do, students acquire not only core subject knowledge and skills, but they also develop so-called twenty-first century skills (e.g., learning and innovation skills, complex communication and social skills, information literacy and technology skills, and self-management and development). These twenty-first century skills are deemed important, to prepare students for participation in a rapidly changing society (NRC, 2012; SLO, 2016). IBL is nationally and internationally recommended as an effective method to achieve learning goals concerning knowledge, skills, and attitudes in various academic domains for students in all grades of elementary education, mainly but not exclusively in science and technology

(Freeman, Eddy, McDonough, Smith, Okoroafor, Jordt, et al., 2014; Henderson, Beach, & Finkelstein, 2011; Inspectorate of Education, 2017; Olson & Riordan, 2012 Verkenningcommissie W&T, 2013).

Teacher Guidance

Reviews and meta-analyses have indeed shown that, among typically developing students, under some conditions IBL is an effective method to achieve learning goals in various domains, such as knowledge and skills (e.g., Alfieri et al., 2011; Furtak, Seidel, Iverson, & Briggs, 2012; Minner, Levy, & Century, 2010). Yet, student outcomes appear to be dependent on careful teacher guidance and direction (e.g., Alfieri et al., 2011; Furtak et al., 2012; Kirschner, Sweller, & Clark, 2006). Specifically, unguided or unassisted IBL generally appears to be less effective than explicit instruction (Alfieri et al., 2011; Kirschner et al., 2006), but when students are provided with adequate teacher guidance during IBL, they have been shown to learn more than students who are taught the same content with explicit instruction (Alfieri et al., 2011; Furtak et al., 2012; Lazonder & Harmsen, 2016). The role of the teacher thus appears to be very important in actively guiding students' IBL activities.

Previous research concerning teacher guidance has shown that the role of the teacher can be varied across multiple dimensions. One dimension is the *amount of teacher direction*, which refers to the amount of influence students have on choices concerning the investigations that they conduct (Dobber et al., 2017; Furtak et al., 2012). Teachers can vary along a continuum from student-directed IBL (i.e., when students are predominantly in the lead to make decisions on what and how they want to learn), via mixed-direction (i.e., both students and teachers make decisions) to teacher-directed IBL (i.e., teachers tell students what and how to learn). A second dimension is *type of teacher guidance*, which refers to the type of assistance that is offered before and/or during the IBL activities. Teachers can vary along a continuum from less to more specific assistance, ranging from process constraints that only

restrict the comprehensiveness of a task to direct explanations that exactly specify how an action should be performed (Lazonder & Harmsen, 2016). A third dimension is *focus of teacher guidance*, which refers to what kind of knowledge or skills the teacher supports when providing guidance. Teachers can vary between meta-cognitive regulation (i.e., how students think and act as scientists), conceptual regulation (i.e., understanding subject-specific knowledge), social regulation (i.e., supporting collaboration and social problem-solving), and procedural regulation (i.e., supporting skills necessary for following the systematic steps involved in science) (Dobber et al., 2017; Gresnigt, 2018; Furtak et al., 2012).

The scientific literature establishes the important role that teachers play for the successful implementation of IBL. Yet, due to the many dimensions of guidance involved, this makes it a demanding task for teachers to accomplish.

Inquiry-Based Learning for Students with SEBD

Results of research on the effectiveness of IBL and the importance of teacher guidance conducted among typically developing students are not necessarily generalizable to specific student populations such as students with Social-Emotional and Behavioral Difficulties (SEBD). Students with SEBD share characteristics that may adversely affect educational performance, including academic, social, vocational or personal skills. Examples of these characteristics include impaired emotion regulation and internalizing and externalizing behavior problems (Furlong, Morrison, & Jimerson, 2004; Gresham & Kern, 2004; Landrum, 2011), problems in executive functioning, control of attention and memory (Diamond, 2013; VandenBroucke, Weeda, Lee, Baeyens, Westfall, Figner et al., 2018), but also difficulties in establishing and maintaining positive social relationships with school personnel and peers (Furlong et al., 2004; Gresham & Kern, 2004). Given the difficulties that these students face, it is questionable whether IBL is a suitable instructional approach for students with SEBD to

achieve various learning goals in terms of knowledge, skills, and attitudes and/or whether specific adjustments to IBL should be made.

On the one hand, IBL may be assumed to be an unsuitable instructional approach for students with SEBD, since they struggle with skills that are required for IBL. For instance, difficulties in social relationships may result in problems with collaborating with fellow-students and difficulties in executive functioning may result in problems in inquiry skills such as generating research questions, planning and organizing the inquiry, and drawing conclusions from the collected data (Brigham, Scruggs, & Mastropieri, 2011). In addition, research has shown that the active role that students get in constructing their own learning process make heavy demands on working memory that cannot be used to learn substantive content (Kirschner, Sweller, & Clark, 2006; Sweller, Kirschner, & Clark, 2007), and off-task behavior may be particularly problematic during generally less structured hands-on IBL activities (Watt, Therrien, & Kaldenberg, 2014). The increased attention for IBL may thus place students with SEBD at a disadvantage to achieve various learning goals concerning knowledge, skills, and attitudes in education.

On the other hand, however, IBL may be a particularly suitable method for students with SEBD. IBL has a motivating effect on students by emphasizing active participation and providing hands-on experiences (Kern, Bambara, & Fogt, 2002), which may be particularly important for students with SEBD who generally are observed to be less engaged and less motivated for academic tasks (Cefai, 2010). Traditional methods place heavy language and literacy demands on students (Parmar, Duluca, & Janczak, 1994) leading to frustration, disengagement, and sometimes even disruptive behavior. The disruptive behavior of students with SEBD not only undermines the influence of teachers on the respective student's behavior and academic achievement, but it may also limit the teacher's influence on other students' behavior and achievement. This makes the population of students with SEBD particularly

challenging to teach and to support for teachers (Goei & Kleijnen, 2009; Hofstetter & Bijstra, 2014). The hands-on experiences and increased opportunities for decision-making during IBL instruction may fulfill the need of students with SEBD to be actively involved in learning (Scruggs & Mastropieri, 2007), resulting in higher engagement and more appropriate classroom behavior (Lane, 2004; Van der Worp-van der Kamp, Pijl, Bijstra, & Van den Bosch, 2014). Hence, it may also be argued that IBL provides opportunities to improve academic outcomes for students with SEBD.

Inclusive Education and Inquiry-Based Learning

With the current international move towards inclusive education (United Nations, 2006; Ledoux & Waslander, 2019; Oh-Young & Filler, 2015) classrooms comprise a more and more diverse student population, including students with SEBD. The question whether IBL is a suitable instructional approach to achieve various learning goals for students with SEBD therefore becomes even more important. Emotional and behavioral interventions, such as social skills training, have long been in the forefront at the expense of academic instruction for students with SEBD (Furlong et al., 2004; Hagaman, 2012), based on the belief that disruptive behavior has to be under control before students with SEBD would be educable in inclusive settings with their typically developing peers.

Educators sometimes still interpret placement of students with disabilities in inclusive settings as an effort for integration and socialization only, without considering learning goals (e.g., Damianidou & Phtiaka, 2018). Over the past decade, however, this belief is changing and researchers as well as teachers have increasingly become aware of the importance of academic interventions and considering learning goals for students with SEBD (Lane, Wehby, & Barton-Arwood 2005; Van der Worp-van der Kamp et al., 2014; Wehby, Falk, Barton-Arwood, Lane, & Cooley, 2003). Recent research has shown that a focus on academic instruction for students with SEBD is often accompanied by non-academic behavioral

improvements, such as increased engagement and motivation and more positive attitudes towards academic learning (Lane, 2004; Van der Worp-van der Kamp et al., 2014). So a focus on IBL instruction may promote inclusive education in which various students – including students with SEBD – can achieve learning goals in terms of knowledge, skills, and attitudes, but also in terms of behavior (e.g., Apps & Carter, 2006; Rizzo & Taylor, 2016; Scruggs, Mastropieri, Berkeley, & Graetz, 2010; Therrien, Taylor, Watt, & Kaldenberg, 2014).

Previous research examining effective instructional strategies for students with SEBD (e.g., Barnett, Fisher, & Frankel, 2018; Tan, 2016; Therrien et al., 2014) and students with disabilities in general (e.g., Apps & Carter, 2006; Rizzo & Taylor, 2016; Scruggs et al., 2010) suggest that IBL may be a suitable instructional approach to achieve various learning goals for students with SEBD. Yet, these existing reviews and summarizing discussions generally stress that it is critical to provide enough structure and additional assistance (Barnett et al., 2018; Rizzo & Taylor, 2016; Therrien et al., 2014), as many students with SEBD may require social-emotional and academic supports in multiple areas (Abels, 2015; Hagaman, 2012). Several examples of potentially effective supports are mentioned (e.g., mnemonic strategies, peer tutoring, and graphic organizers; see for example Watt et al., 2014), but differentiation seems critical to meet the needs of students with SEBD in particular. Differentiation can be defined as an educational approach in which teachers proactively adjust curricula, teaching methods, resources, learning activities, and student products to students' needs in order to maximize individual students' and classroom learning (Tomlinson et al., 2003). Differentiation implies that teachers have knowledge of the needs of individual students and that they are able to tailor the instructional context to these needs. This suggests that the role of the teacher is as important – or maybe even more important – in actively guiding IBL activities of students with SEBD as has been found among typically developing students (e.g., Alfieri et al., 2011; Furtak et al., 2012; Kirschner et al., 2006; Minner et al., 2010).

Present Study

Given the current approach in inclusive education to optimize different learning outcomes concerning knowledge, skills, attitudes, and behavior in concert, it is of great interest to discuss these learning goals in parallel in the context of IBL for students with SEBD. Despite of several reviews and summarizing discussions about the effectiveness of IBL for students with SEBD and various other disabilities, a systematic overview is lacking of the current scientific knowledge about these learning outcomes of IBL for students with SEBD.

To shed more light on the suitability of IBL for students with SEBD, we conducted a systematic review of the literature to examine (a) what is known about the use of IBL instructional methods for students with SEBD; (b) what is known about whether specific adjustments to IBL instructional methods are made in terms of teacher guidance (i.e., direction, type, and focus) and differentiation (i.e., adjustments of curricula, teaching methods, resources, learning activities, and student products); and (c) what is known about the effectiveness of IBL to achieve learning goals in various domains (knowledge, skills, attitudes, and behavior). In addition, we sought to make recommendations for future research that has the aim to reveal the optimal settings of IBL for students with SEBD.

Method

We conducted the systematic review and reported the results in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Liberati et al., 2009; Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

Methods of the analyses and inclusion criteria were specified in advance and documented in a protocol which is registered in the International prospective register of systematic reviews (PROSPERO) under ID number 116251.

Literature Search

We developed our literature search using previous systematic reviews and meta-analyses of IBL (e.g., Dobber et al., 2017; Furtak et al., 2012; Lazonder & Harmsen, 2016), and using previous systematic reviews and meta-analyses of teaching/instruction for students with Emotional and Behavioral Difficulties (e.g., Therrien et al., 2014; Van der Worp et al., 2014). We incorporated the fact that educators and researchers use both a rich vocabulary beyond IBL to describe this method of instruction (Furtak et al., 2012) as well as various terms for students with SEBD¹ (Cullinan, 2004). To capture the diversity of terms used for both IBL and SEBD, we appended the keywords of the previously mentioned reviews and meta-analyses and conducted a new search with the following IBL search terms: “inquiry* learning”, “inquiry* teaching”, “discovery* learning”, “discovery* teaching”, “learning inquiry*”, “teaching inquiry*”, “learning discovery*”, “teaching discovery*”. We crossed each of these search terms with each of the following EBD search terms: “behavior* problem*”, “behavior* disorder*”, “behavior* need*”, “behavior* difficult*”, “behavior* disturb*”, “emotion* problem*”, “emotion* disorder*”, “emotion* need*”, “emotion* difficult*”, “emotion* disturb*”, EBD, SED, SEBD, BESD, “special education”, “conduct disorder”, CD, “oppositional defiant disorder”, ODD, “attention-deficit hyperactivity disorder”, ADHD, “autism*”, ASD, “anxiety* disorder*”. We searched the electronic databases PsycInfo, ERIC, and PiCarta for studies carried out between January 2000 and December 2018.

¹ In some European countries, such as the Netherlands, students with SEBD qualify to receive special education services for SEBD when they show severe emotional and behavioral problems at school and at home or in the community (either formally diagnosed or not); their participation in education is severely limited by their emotional and behavioral problems (i.e., they show impairments in learning and/or their interactions with school personnel and/or classmates); and the school’s available support services are insufficient to meet the students’ needs (LCTI, 2006; Meijer, 2003). Students with SEBD are eligible for special education services, regardless of the origination of these problems. Consequently, students with various psychiatric disorders, such as Autism Spectrum Disorders, Attention-Deficit Hyperactivity Disorders, and Disruptive, Impulse-Control, and Conduct Disorders, receive special education services for SEBD. To this end, the most common psychiatric diagnoses found among students who receive special education services for SEBD were added to our list of search terms.

In addition to searching in electronic databases, we checked the reference lists and citations of relevant articles that fulfilled the specified eligibility criteria (a snowballing technique). This resulted in an additional set of relevant articles, for which we again checked the reference lists and searched for citing articles.

Eligibility Criteria

We included in our review those studies which met the following eligibility criteria:

- Describes IBL methods according to the definition of Lazonder and Harmsen (2016) defining IBL as a method *“in which students conduct experiments, make observations or collect information in order to infer the principles underlying a topic or domain. These investigations are governed by one or more research questions, either provided by the teacher or proposed by the student; adhere (loosely) to the stages outlined in the scientific method; and can be performed with computer simulations, virtual labs, tangible materials, or existing databases”* (p. 2);
- Involves students in K-12 schools;
- The IBL condition contains at least one student with SEBD according to the definition of Emotional or Behavioral Disorders of Forness and Knitzer (1992, as cited in Landrum, 2011):
 - I. The term emotional or behavioral disorder means a disability characterized by emotional or behavioral responses in school programs so different from appropriate age, cultural, or ethnic norms that they adversely affect educational performance, including academic, social, vocational, or personal skills, and which*
 - (a) is more than a temporary, expected response to stressful events in the environment;*
 - (b) is consistently exhibited in two different settings, at least one of which is school related; and*
 - (c) persists despite individualized interventions within the education program, unless, in*

the judgment of the team, the child's or youth's history indicates that such interventions would not be effective.

Emotional or behavioral disorders can co-exist with other disabilities.

II. This category may include children and youth with schizophrenic disorders, affective disorders, anxiety disorders, or other sustained disturbances of conduct or adjustment when they adversely affect educational performance in accordance with section I (p. 13);

- Students with SEBD have IQ scores ≥ 80 (as we assumed that, based on the cognitive demands of IBL, students with comorbid low IQ would require different/more extensive adjustments than students with EBD alone and this was not what we wanted to examine);
- Published in peer-reviewed journals;
- Written in English;
- Published between January 2000 and December 2018.

The first author reviewed the articles at each stage of the literature search (i.e., screening titles, screening abstracts, and reading full-texts) to determine inclusion eligibility. In case of doubt, the other authors were consulted. A flowchart of the study selection procedure is shown in Figure 1.

Data Collection Process

In order to provide a complete overview of all articles that concerned IBL for students with SEBD in the period from 2000-2018, we also included 6 meta-analyses/reviews and 6 literature studies in our initial search, as can be seen in Figure 1. However, we could only code the empirical studies ($n = 14$).

From these 14 empirical studies, the first author coded the following information whenever available: (1) study characteristics (i.e., authors and design); (2) participant characteristics (i.e., sample size, grade, sex, and diagnostic labels); (3) IBL characteristics (i.e., description of IBL instructional activity and setting); (4) IBL adjustments in terms of teacher guidance

Figure 1. Flow diagram of study selection procedure.

Note. ^a Reasons to exclude records were: not IBL; not SEBD; comorbid intellectual disability; participants too young/old; Students With Disabilities (SWD) not defined; or combinations of the above.

DES = descriptive study; EXP = experimental study; QL = qualitative study; QT = quantitative study; MA = meta-analysis.

(i.e., direction, type, and focus of teacher guidance) and differentiation (i.e., adjustments of curricula, teaching methods, resources, learning activities, and student products); and (5) student outcomes (i.e., knowledge, skills, attitudes, and behavior). The fourth author independently coded 29% of the empirical studies ($n = 4$). Inter-rater reliability was 79.8%. The two raters discussed rating disagreements to achieve a single rating for each measure. Subsequently, consensus for the remaining articles including an initially disagreed variable was reached in an iterative way.

Risk of Bias

To examine the quality of eligible studies, we used the Quality Assessment Tool for Quantitative Studies (National Collaborating Centre for Methods and Tools, 2008) for all quantitative empirical studies included in our review. Studies receive ratings on a three-point Likert scale ('strong', 'moderate', or 'weak'), indicating low, medium, and high risk of bias, respectively. Studies were examined for selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts, intervention integrity, and analysis (see supplementary material Table S1).

For qualitative empirical studies, we combined the criteria of Mays and Pope (2000) with the ten CASP criteria for qualitative studies (CASP, 2018), which has been done in previous research (e.g., Humphreys, Johnson, Richardson, Stenhouse, & Watkins, 2007). For comparability, we used the same three-point Likert scale as was used for quantitative studies. Studies were examined for clarity of research question(s), study design, data collection,

analyses, conclusion, and reflexivity (see supplementary material Table S1). For mixed-method studies, we assessed risk of bias with both assessment tools for quantitative and qualitative studies.

The first and fourth author independently assessed risk of bias of all empirical studies included in the present review – except for two mixed-methods studies on teacher behavior and teacher professionalization (Brusca-Vega et al., 2011, 2014) which we coded collaboratively. Inter-rater reliability for the independently coded studies was 75%, 66% and 75% for the quantitative, qualitative, and mixed-methods studies, respectively. We retrieved discrepancies in global ratings for all but one study, both caused by differences in interpretation of the criteria and interpretation of the study. This indicates that we had to calibrate the use of the risk of bias criteria to the variety of designs, methods and analyses used in the heterogeneous set of studies retrieved in this systematic review. All disagreements were resolved by discussion between the two assessors.

Risk of bias across studies could not be addressed statistically, due to the large variation in study designs and outcome measures of the included studies. It seems unlikely that many studies were unpublished due to non-significant results, since the studies in the field of IBL for students with SEBD are still rare. Besides, the present review shows that several of the published studies also showed non-significant effects.

Results

In this section, the results of the analyses are discussed in separate steps. First, we present an overview of the studies on IBL for students with SEBD that were found between 2000 and 2018. Second, we describe the use of IBL instruction for students with SEBD and the specific adjustments made for this student population in terms of teacher guidance (i.e., direction, type, and focus) and differentiation (i.e., adjustments of curricula, teaching methods, resources, learning activities, and student products). Third, we describe the

effectiveness of IBL instruction for students with SEBD to achieve learning goals in terms of knowledge, skills, attitudes, and behavior.

Overview of Research on IBL for Students with SEBD from 2000-2018

A total of 26 studies published between 2000 and 2018 were found (see Figure 1). We will start with a summary of the discussion-based studies ($n = 12$). Subsequently, we will focus in depth on the 14 empirical studies that were coded.

Discussion-based studies on IBL for students with SEBD from 2000-2018. The discussion-based articles included in our initial search ($n = 12$) – articles that do not present any new or original research, such as meta-analyses, reviews, literature studies and “how to” articles – show that IBL instruction is used for students with disabilities and for students with SEBD specifically, but that specific adjustments is recommended to be made to support the special needs of students with disabilities and students with SEBD in particular (e.g., Rizzo & Taylor, 2016; Therrien et al., 2014). Examples of such academic and behavioral supports include explicit instruction, graphic organizers, mnemonic strategies, Scientific Writing Heuristic, peer-assisted learning, self-monitoring tools, and use of technology (e.g., Ackerman, 2017; Barnett et al., 2018; Camenzuli, 2015; Maroney et al., 2003; Taylor, 2016; Villanueva et al., 2012; Watt et al., 2014). Provided that the method includes enough academic and behavioral supports to support the students’ special needs, IBL instruction may be effective to achieve learning goals in various domains, both for students with disabilities (e.g., Apps & Carter, 2006; Scruggs et al., 2010; Rizzo & Taylor, 2016; Villanueva et al., 2012) and for students with SEBD specifically (e.g., Barnett et al., 2018; Tan, 2016; Therrien et al., 2014). However, convincing evidence for these recommendations needs to come from empirical studies.

Empirical studies on IBL for students with SEBD from 2000-2018. Table 1 shows the design, participants, and setting of each empirical study reviewed. Most studies only included

Table 1. *Descriptive Characteristics of Studies Involving Inquiry-Based Learning for Students with SEBD*

	Author(s)	Design	Participants			Setting
			Total number of participants	Number of participants with SEBD; SEBD diagnoses	Sex; grade	
1	Abels (2014)	QL DES (case study)	1 classroom, $n = 20$ students	Five students officially had special needs, reaching from severe to mild disabilities, from mental retardation to autism to ADHD and emotional/behavioral issues	2 boys, 3 girls; 8 th grade	inclusive middle school
2	Bargerhuff (2013)	QL DES (case study)	1 school, $n = 80$ students	10% had been identified as needing special education services; most students' disabilities included either specific LD or ASD and one student was also hearing impaired with ED and ADHD	9 th grade	inclusive public STEM school
3	Belland et al. (2006)	QL DES	3 classrooms, study sample of $n = 6$ students	one student with ED	girl with SEBD	inclusive middle school
4	Belland et al. (2009)	QL DES (case study)	20 students in the unit, study sample of $n = 3$ students	one student with LD and ADHD	boy with SEBD; 7 th grade	inclusive middle school
5	Brusca-Vega et al. (2011)	*MM: QL DES characteristics of co-taught IBL classrooms	3 classrooms, $n = 5$ teachers		6 th and 7 th grade	inclusive middle school
		*MM: QT EXP student science achievement (experiment – no control)	3 classrooms, $n = 62$ students	two students with mild autism	6 th and 7 th grade	inclusive middle school
6	Brusca-Vega et al. (2014)	* MM: QT EXP teacher classroom behavior (experiment – no control)	16 schools, $n = 58$ teachers	four schools that served only students with serious emotional and behavioral problems	Undefined	inclusive classrooms; self-contained settings; resource settings
		* MM: QL DES teacher interventions (case study/action research)	$n = 3$ examples of action research projects	example of one certified K-12 special educator, who taught in a special school for students with severe emotional disturbance	7 th and 8 th grade	special school for students with severe emotional disturbance
7	Camenzuli & Buhagiar (2014)	* MM: QL DES (action research)	single 'core programme' classroom teacher			resource room in mainstream secondary school for boys

		* MM: QT EXP (experiment – no control)	‘core programme’ support classroom of $n = 13$ students from four mainstream classes	thirteen students with SEBD (either formally diagnosed or not)	all boys; ages 11-16	resource room in mainstream secondary school for boys
8	Mastropieri et al. (2001)	QT DES (experiment – no control)	3 schools, $n = 75$ students	one student with high-functioning autism (out of 51 students classified as having high-incidence disabilities, mostly LD)	43 boys, 32 girls; grades 1-6	inclusive elementary schools
9	Mastropieri et al. (2006)	QT EXP (experiment + control)	1 school, 13 classrooms, $n = 213$ students	seven students classified with EBD	109 boys, 104 girls; 8 th grade	inclusive middle school
10	McCarthy (2005)	QT EXP (experiment + control)	2 classrooms, $n = 18$ students	eighteen students with serious emotional disturbance (9 experimental, 9 control), with various secondary classifications such as LD, MR, CD, ODD, and/or ADHD	16 boys, 2 girls; mean age 12 years and 8 months	self-contained middle school classrooms in a partial hospitalization setting
11	Palincsar et al. (2001)	* MM: QL DES (design experiment)	3 schools, 4 classrooms, $n = 4$ teachers		4 th and 5 th grade	inclusive classrooms in the Guided Inquiry supporting Multiple Literacies (GIsML) Community of Practice
		* MM: QT DES (experiment – no control)	3 schools, 4 classrooms, $n = 111$ students	five students with emotional impairment (out of 19 students with special needs)	4 th and 5 th grade	inclusive classrooms in the GIsML Community of Practice
12	Rapp (2005)	QL DES	1 classroom, $n = 26$ students	one student with LD and emotional impairment (out of six students who were eligible for special education services)	girl with SEBD; 3 rd grade	inclusive general education classroom
13	Taylor et al. (2018)	QT EXP (randomized experiment + control)	6 schools, $n = 26$ students	undefined how many typically developing students and students with disabilities were in treatment ($n = 3$) or control ($n = 3$) schools; students with high incidence disabilities included LD and EBD	grades 3-5	inclusive elementary science classrooms
14	Zembylas & Isenbarger (2002)	QL DES (case study)	1 classroom, $n = 1$ student	one student with LD, ADHD, and speech impairment	boy with SEBD; 4 th grade	inclusive science classroom

Note. EXP = Experimental research; DES = Descriptive research; DISC = Discussion-based research; MM = Mixed-methods research; QL = Qualitative; QT = Quantitative; LD = Learning Disability; ASD = Autism Spectrum Disorder; ED = Emotional Disability; ADHD = Attention-Deficit Hyperactivity Disorder; EBD = Emotional and Behavioral Disorder; MR = Mental Retardation; CD = Conduct Disorder; ODD = Oppositional-Defiant Disorder.

a limited number of students with SEBD and participant characteristics (e.g., diagnostic labels, sex and grade level) were not always well-described. All but two studies were conducted in the United States and the majority of the reviewed studies were conducted within inclusive classrooms in elementary and middle schools.

The risk of bias within the majority of empirical studies was rated as high, except for one quantitative study (Mastropieri et al., 2006) which received a low rating of risk of bias and two qualitative studies which received moderate ratings of risk of bias (Belland et al., 2009; Rapp, 2005). In addition, two mixed-methods studies (Brusca-Vega et al., 2011; Camenzuli & Buhagiar, 2014) received moderate and low risk of bias ratings, respectively, for the quantitative part of the study only. Global ratings of risk of bias for each study and more detailed information on criteria for quantitative and qualitative studies can be found in the supplementary material Table S1. Given the large variation in reported IBL instructional activities, specific adjustments in terms of teacher guidance and differentiation, and student outcomes, we considered it useful to include all studies in our synthesis to provide a complete overview of what is known – despite the high risk of bias in the majority of the studies.

Use of IBL Instruction and Specific Adjustments Made for Students with SEBD

Table 2 summarizes the IBL instructional activities for each study. Studies varied widely in their descriptions of IBL instructional activities, ranging from implementing activity-based instructional units based on the district curriculum (Zembylas & Isenbarger, 2002) or going on field trips to a science museum (Rapp, 2005) to participating in an open-inquiry ‘Lernwerkstatt’ (Abels, 2014) or participating in a community of practice using cycles of investigation stemming from a professional development project (Palincsar et al., 2001). In the discussing specific adjustments made for students with SEBD we distinguish Teacher Guidance and Differentiation.

Table 2. *Summary of IBL Activities*

	Author(s)	IBL instructional activity
1	Abels (2014)	One open-inquiry 'Lernwerkstatt' lasting three days in which students have access to a room in which they encounter stimulating phenomena, objects and materials which are supposed to trigger questions in their own field of interest to start immediately with an inquiry.
2	Bargerhuff (2013)	Faculty and staff use inquiry, project-based learning with real-life applications, and cooperative group learning. Students participate in authentic, real-world experiences with practicing scientists, engineers, and other professionals in research and industry.
3	Belland et al. (2006)	A PBL unit on the physical accessibility of Brownsville in which students worked in small groups led by one of the teachers to either go out in the community (i.e., taking pictures and video, recording data about the physical accessibility of sidewalks, doors, and public places to people with physical disabilities) or to complete research and writing activities using laptop computers.
4	Belland et al. (2009)	A two-week PBL unit on the Human Genome Project (HGP) in which students were asked to assume a position on the HGP based on their stakeholder perspective (i.e., doctors or religious leaders), outline a plan for promoting their positions, and argue their positions during a debate at the end of the unit for which they had to develop a promotional brochure to outline their positions.
5	Brusca-Vega et al. (2011)	Primary instructional pedagogies are inquiry, hands-on active learning, multisensory methods, student-to-student interaction, discourse and reflective thinking, and, to a lesser extent, the use of reading materials and other research tools. Class sessions began with a <i>bellringer</i> assignment, followed by classroom discussion. The majority of the lessons contain activities that involved experiential learning and hands-on materials in small groups, with students observing, note-taking, and discussing. Lessons that did not involve an experiential component typically included reviews of science concepts/vocabulary, reading materials aloud, and watching/discussing content-related videos.
6	Brusca-Vega et al. (2014)	Example in which the teacher had the class select science topics and experiments for two-week mini-units. Each unit included activities that linked the new topic to prior knowledge, reading and discussion about the topic, taking turns at leading activities, and highly structured hands-on experimentation.
7	Camenzuli & Buhagiar (2014)	The teacher planned his lessons, which still followed the normal school mathematics syllabus, to include and emphasize a number of important IBL processes, such as active participation, included "posing questions, making decisions, designing experiments, predicting, exploring alternative methods, discussing, collaborating, checking each other's work, summarizing and communicating results".
8	Mastropieri et al. (2001)	Thirty-minute standardized constructivist learning activity involving the principles of density and buoyancy, in which students were asked about their preconceptions (on floating/sinking), to make predictions, and to make generalizations (about water/oil) while the researcher was conducting the experiment.
9	Mastropieri et al. (2006)	<p>* Control condition: teachers began lessons with a daily review, presented new information during teacher lecture with students taking class notes, teachers led laboratory-like class activities, and students completed supplementary textbook materials (e.g., worksheets with fill-in-the-blank, matching, vocabulary, and short-answer items).</p> <p>* Experimental condition: in which all teacher presentations were identical to those in the control condition. However, time typically spent completing worksheets was instead devoted to peer-assisted learning with three-level differentiated hands-on curriculum enhancement materials (e.g., focused on creating charts and graphs from different types of data or focused on identifying independent and dependent variables).</p>
10	McCarthy (2005)	<p>* Eight-week traditional textbook approach: including 5-10 minutes of review, a 10-minute teacher demonstration, 15-20 minutes of textbook reading and discussion, and 10 minutes of independent practice based on the previously read selection.</p> <p>* Eight-week hands-on thematic approach: including 5-10 minutes of review, 30-40 minutes of students conducting experiments in groups of two or three while the teacher provided guided practice, and 5-10 minutes of review of the concepts and results of the experiments.</p>

11	Palincsar et al.
(2001)	The inquiry is guided by a question that is broad and identifies a general conceptual terrain (e.g., How does light interact with matter?). Inquiry proceeds through cycles of investigation stemming from more specific questions (e.g., How does light interact with mirrors?) or a particular phenomenon (e.g., refraction of light through various liquids). Students gather data, begin to identify patterns in these data, and try out their explanations by manipulating the phenomenon, and by publicly sharing their data they compare and contrast their ideas with others. Having partially addressed the topic of inquiry, they return to the engage phase, perhaps with a refined question/new materials, tools or procedures with which to inquire. Students also engage in second-hand investigations, in which they consult text for the purpose of learning about others' experiences and interpretations of the physical world and concepts created to describe it.
12	Rapp (2005)	* Four half-day field trips to a science museum with the philosophy that children learn best by doing—touching, handling, assembling, disassembling, and using. The exhibits helped to bring concepts in science, technology, natural history, mathematics, history, art, and world cultures to life. At the time of the study, the museum had approximately 140 exhibits arranged in four sections that students toured in the same order: (a) the human body; (b) the natural environment, such as bubbles and fossils; (c) light and optical illusions; and (d) mechanical operations of various objects, such as toilets, circuits, and pulleys.
* Four full-day classroom visits were not further explained.
13	Taylor et al.
(2018)	* Treatment condition: the SWH is designed to allow students to develop and use “questions, claims, and evidence” to display understanding of science content and concepts by promoting the use of scientific “big ideas”, argumentation/negotiation, hands-on experimentation, and multimodal representation. In addition, peer-based instructional strategies, writing-to-learn processes, and teacher/student templates are used to teach students science content and the processes of science from a student-directed prospective.
14	Zembylas &
Isenbarger (2002)	* Control condition: science instruction considered “business as usual” in that the teaching method suggested by the school district was used.
The teacher teaches activity-based, inclusive science based on the district curriculum but she also elicits children’s ideas and encourages them to conduct open-ended inquiries to research topics of their own interest. She implemented many activity-based instructional units on various topics that emphasised the integration of science with art, mathematics and social studies.

Note. QL = Qualitative outcome; QT = Quantitative outcome.

Teacher Guidance. Table 3 summarizes adjustments made in terms of teacher guidance. The majority of the studies either used teacher-directed IBL instruction or mixed student-teacher direction – indicating that teachers play an important role to support students with disabilities and students with SEBD specifically. An example of teacher-directed IBL instruction is that teachers select the research topic, the level of materials for students to use, but also the composition of student groups based on their ability levels (Mastropieri et al., 2006). An example of mixed direction, in contrast, includes that students first collaborate with the teacher to combine ingredients into a cake mixture, with the teacher initiating a discussion about physical and chemical changes afterwards. In a second experiment, students manipulated materials and discovered new concepts on physical and chemical changes themselves (McCarthy, 2005). The two single studies that used student-directed IBL instruction commented that the student-directedness of the setting may have caused specific problems, such as no opportunities to explicitly learn about inquiry (Abels, 2014) and minimal generalization of knowledge and skills from a museum to a classroom setting (Rapp, 2005).

The limited number of studies that do report on the type of teacher guidance (see Table 3) seems to indicate that multiple types of teacher guidance – predominantly more specific types of assistance – are applied during IBL instruction to support students with SEBD. The most common types of teacher guidance were *direct instructions or explanations* in which teachers specified exactly how to perform an action ($n = 6$), *scaffolds* in which teachers explained or took over the more demanding parts of an action ($n = 7$), *heuristics* that entail reminders to perform an action combined with suggestions of how to perform that action, either at the outset of the activity and/or as adaptive response to student actions ($n = 5$), and *prompts* or timed cues to perform an action ($n = 5$) (Abels, 2014; Belland et al., 2006, 2009; Brusca-Vega et al., 2011, 2014; Camenzuli & Buhagiar, 2014; Palincsar et al., 2001).

Table 3. *Summary of Adjustments to IBL Instruction for Students with SEBD (i.e., Teacher Guidance and Differentiation) and Student Outcomes*

Author(s)		Direction			Type of teacher guidance						Focus of guidance				Differentiation for SWD*					Student outcomes				
		Student-directed	Mixed direction	Teacher-directed	Unassisted	Process constraints	Status overviews	Prompts	Heuristics	Scaffolds	Explanations	Metacognitive regulation	Conceptual regulation	Social regulation	Procedural regulation	Curricula	Teaching methods	Resources	Learning activities	Student products	Knowledge	Skills	Attitudes	Behavior
1	Abels (2014)	Y	N	N	N			Y		Y	Y		Y	Y				Y	*					
2	Bargerhuff (2013)													Y	Y	Y	Y							
3	Belland et al. (2006)	N	N	Y	N			Y	Y	Y	Y		Y	Y	Y		Y		Y		+ ^{QL}	+ ^{QL}		+ ^{QL}
4	Belland et al. (2009)	N	Y	N	N			Y	Y	Y	Y	Y	Y	Y			Y	Y	Y			+ ^{QL}		
5	Brusca-Vega et al. (2011)	N	N	Y	N	Y	Y	Y	Y	Y	Y		Y	Y	Y		Y*	Y	Y	Y	+ ^{MM}			+ ^{QL}
6	Brusca-Vega et al. (2014)	N	Y	N	N				Y	Y	Y		Y	Y	Y	Y*	Y*	Y*	Y*	Y	+ ^{QL}		+ ^{QL}	+ ^{QL}
7	Camenzuli & Buhagiar (2014)	N	N	Y	N					Y		Y	Y	Y		*	*		*		+ ^{MM}		+ ^{QL}	+ ^{QL}
8	Mastropieri et al. (2001)	N	N	Y													Y	Y			+ ^{QTa}			
9	Mastropieri et al. (2006)	N	N	Y									Y	Y	Y	Y	Y	Y	Y		+ ^{MM}		0 ^{QT}	

10	McCarthy (2005)	N	Y	N	N							Y	Y	*	*	*	*	*	+ ^{QTb}	0 ^{QTc}
11	Palincsar et al. (2001)	N	Y	N	N	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	0 ^{QTd}	? ^{QTe}
12	Rapp (2005)	Y	N	N	Y	N	N	N	N	N	N			Y*	Y*	Y	Y*		+ ^{QL}	+ ^{QL}
13	Taylor et al. (2018)	N	Y	N	N							Y	Y			Y	Y	Y		+ ^{QL}
14	Zembylas & Isenbarger (2002)	N	Y	N	N							Y		Y	Y	Y*			+ ^{QL}	+ ^{QL}

Note. * For students with SEBD specifically. ^a SWD with $IQ \geq 80$ were equivalent in performance to typically developing students on all aspects of performance, while SWD with $IQ < 80$ performed significantly lower than the other two groups. ^b Students in the IBL condition performed significantly better on a short-answer test and on a hands-on assessment than students in the control condition, while no differences between groups were found for performance on a multiple-choice test. ^c From qualitative data it seemed that students in the control condition required slightly more teacher attention and direction than students in the IBL condition, while quantitative behavioral tallies did not show significant differences between groups. ^d In three of the eight classrooms, SWD showed significant learning gains over time, whereas in the other five classrooms no significant learning gains were found. ^e The researchers reported that they administered written pre- and post-assessments of students' attitudes towards and beliefs about the nature of science and scientific reasoning, but results of these measures were not reported in the article.

Y = Yes; N = No; blank = not reported; SWD = Students With Disabilities; QL = Qualitative outcome; QT = Quantitative outcome; MM = mixed-methods (both qualitative and quantitative); + = positive outcome; 0 = neutral outcome; - = negative outcome.

Only one study reported unassisted IBL instruction (Rapp, 2005). In this case, students could choose to manipulate objects/materials on any topic in a hands-on children's museum and the researchers reported that once physical access was provided, the exhibits inherently accommodated special needs.

With regard to the focus of teacher guidance, the twelve studies reported on conceptual regulation ($n = 10$), social regulation ($n = 10$) and/or procedural regulation ($n = 8$). Teachers guided students in understanding subject-specific knowledge, for example, by helping students recall the content of the previous week (Belland et al., 2006), providing teacher/student templates to teach students science content (Taylor et al., 2018), and discussing and displaying posters of new science terms matched with realistic pictures (Brusca-Vega et al., 2011). Teachers guided students in successful collaboration and social problem-solving, for instance, by monitoring the interactions of small groups (e.g., Bargerhuff, 2013; Palincsar et al., 2001), providing feedback about their efforts to work together (Palincsar et al., 2001) and intervening with some groups (Bargerhuff, 2013), but also by pairing students who required assistance with higher achieving partners (Mastropieri et al., 2006). Teachers guided students in acquiring skills necessary for following the systematic steps involved in science, for instance, by directly instructing what procedures the students would follow during the lesson (Belland et al., 2006), helping the students manage the workload (Bargerhuff, 2013), and covering roles, rules and materials before starting IBL activities (Mastropieri et al., 2006). A focus on metacognitive regulation – that is, how teachers guide students to think and act as scientists – was less often found ($n = 5$).

Differentiation. Table 3 also summarizes adjustments to IBL instruction for students with disabilities, and students with SEBD specifically, in terms of the five dimensions along which teachers can differentiate during their lessons. That is, teachers can proactively adjust curricula, teaching methods, resources, learning activities, and student products to students'

needs in order to maximize individual students' and classroom learning (Tomlinson et al., 2003). Differentiation in teaching methods (i.e., teachers adjust their instructions and supports to individual students' needs) and learning activities (i.e., teachers use a variety of activities to achieve learning goals for different students) were the most common adjustments – both for students with disabilities in general and for students with SEBD specifically. Examples of differentiation in teaching methods include preteaching (McCarthy, 2005); guided practice (e.g., Belland et al., 2009; McCarthy, 2005; Palincsar et al., 2001); using various instruction modes such as lectures, instruction videos, computer programs, group discussions, and field trips (e.g., Abels, 2014; Belland et al., 2006; Camenzuli & Buhagiar, 2014; Mastropieri et al., 2001; Taylor et al., 2018); and teaching various strategies (e.g., literacy-strategies, mnemonic strategies, or note-taking strategies) (Abels, 2014; Brusca-Vega et al., 2014). Examples of differentiation in learning activities include, amongst others, meaningful and contextualized activities (Bargerhuff, 2013; Rapp, 2005); variation in learning activities such as highly structured hands-on experiments (Belland et al., 2006), collaborative learning (Brusca-Vega et al., 2014), or having students design their own activities (Zembylas & Isenbarger, 2002); a mixture of learning modes (e.g., visuals, audios, active learning approach) (e.g., Abels, 2014; Belland et al., 2006; Camenzuli & Buhagiar, 2014; Mastropieri et al., 2001; Taylor et al., 2018); and encouraging participation of students with disabilities in small groups in various ways (e.g., assigning roles during group work or each student must contribute at least one idea orally) (Belland et al., 2009; Brusca-Vega et al., 2011, 2014).

Differentiation in resources (i.e., teachers provide low achieving students with additional means or resources to compensate for their difficulties) was common for students with disabilities in general, but not for students with SEBD, while differentiation in curriculum (i.e., teachers provide different students with different content) was mentioned more often for students with SEBD specifically than for students with disabilities in general.

Examples of additional resources for students with disabilities in general include content maps/guides (Brusca-Vega et al., 2011; Palincsar et al., 2001; Taylor et al., 2018), word and picture symbol cards (Abels, 2014), criteria lists for research questions or lab book entries (Abels, 2014; Palincsar et al., 2001), unique use of technology (Bargerhuff, 2013; Brusca-Vega et al., 2014), peers/paraprofessionals acting as scribes (Brusca-Vega et al., 2014; Palincsar et al., 2001), and even parental involvement (Rapp, 2005). Examples of adjustments to curricula made include that teachers chose activities for students that were neither too difficult nor too easy (Camenzuli & Buhagiar, 2014; Mastropieri et al., 2006), selected reading materials at the student's reading level (rather than grade level) (Brusca-Vega et al., 2014), offered enrichment activities and special education considerations (McCarthy, 2005), and that students provided input on what they wanted to learn (Brusca-Vega et al., 2014), with the predominant goal to prevent disruptive behavior from happening.

Differentiation in student products (i.e., teachers allow students to show in different ways that they master the content) was neither prevalent for students with disabilities in general, nor for students with SEBD specifically. The few examples mentioned included multimodal representation (e.g., drawing or writing) of subject understanding in response to assignments (Brusca-Vega et al., 2011, 2014; Palincsar et al., 2001) and hands-on assessment of subject understanding (McCarthy, 2005).

Effectiveness of IBL to Achieve Learning Goals for Students with SEBD

Table 3 summarizes outcomes of IBL instruction for students with SEBD in terms of knowledge, skills, attitudes, and behavior. Knowledge and behavior were assessed most often as student outcomes. The studies reporting on subject knowledge/achievement or conceptual understanding generally suggest that students with disabilities – including those with SEBD who had received IBL instruction, made significant achievement gains over time. Positive results were found both when measured with quantitative assessments such as post-tests,

high-stakes tests or annual examinations (e.g., Brusca-Vega et al., 2011; Mastropieri et al., 2001, 2006; McCarthy, 2005) and/or qualitative assessments such as teacher perceptions (e.g., Belland et al., 2006; Rapp, 2005), including multiple studies with low risk of bias. The studies reporting on behavioral outcomes were mostly qualitative in nature. Students reported, for instance, that they had fewer conflicts with peers and staff (Camenzuli & Buhagair, 2014), and teachers reported improved classroom behavior (e.g., Belland et al., 2006; Brusca-Vega et al., 2011, 2014). Teachers suggest that this improvement in behavior may be due in part to a less rigid classroom environment, a more active and collaborative learning approach, and to increased motivation and enjoyment on the students' part (e.g., Belland et al., 2006; Camenzuli & Buhagiar, 2014). The two quantitative studies that assessed behavior, showed mixed results. One study found more positive behavior (i.e., instructional engagement) in IBL classrooms than in control classrooms (i.e., using traditional instruction) – up to an engagement level similar to typically developing students (Taylor et al., 2018), while another study found no differences in the number of special behavioral tallies between IBL and traditional classrooms (McCarthy, 2005).

Only in a minority of the studies skills and attitudes were assessed as student outcomes, and they were measured in various ways. In addition to that, all but one study were qualitative in nature. With regard to skills, studies reported that teachers perceived students with disabilities to show improved social skills (Belland et al., 2006; Rapp, 2005; Zembylas & Isenbarger, 2002), technical skills including digital video editing and use of Microsoft PowerPoint and Word (Belland et al., 2006), and inquiry skills (Zembylas & Isenbarger, 2002). With regard to attitudes, the single quantitative study showed that students with disabilities – including those with SEBD – as well as typically developing students showed a neutral attitude towards experimental materials (Mastropieri et al., 2006), whereas the qualitative assessments of student attitudes were all positive. Students reported positive

attitudes towards their experience with IBL instruction (Rapp, 2005), and increasingly positive attitudes towards science (Zembylas & Isenbarger, 2002) and learning in general (Brusca-Vega et al., 2014; Camenzuli & Buhagiar, 2014) as compared to the situation in which they received traditional instruction.

Discussion

The present systematic review set out to summarize the knowledge available about the use of IBL instructional methods and its adjustments for students with SEBD and whether this instructional method is effective to achieve learning goals with this specific student population. Moreover, we aimed to provide recommendations for future studies that would further reveal the optimal settings of IBL for students with SEBD. First, results of our study indicate that there have been various initiatives to use IBL as an instructional method for students with SEBD, but there is great variety in how IBL is applied in schools and classrooms. That is, IBL instructional methods range from single classroom activities within existing curricula (e.g., Zembylas & Isenbarger, 2002) to complete IBL school design (e.g., Bargerhuff, 2013; Palincsar et al., 2001). Regardless of how IBL instructional methods were applied, there is strong agreement among studies that teachers play an important role in making adjustments in terms of teacher guidance and differentiation. Given the multiple-step process and relative open-endedness of IBL activities (Lazonder & Harmsen, 2016; Pedaste et al., 2015), and the common setting of small group work (Dobber et al., 2017), teachers need to provide sufficient structure in terms of both teacher direction and guidance.

IBL instruction is, however, often not only used and adjusted for students with SEBD specifically. The majority of the studies concerned inclusive classrooms, consisting of typically developing students and students with various disabilities – ranging from learning disabilities, cognitive disabilities, and social-emotional and behavioral disabilities to multiple

disabilities. Consequently, it is difficult to pinpoint which specific adjustments to IBL instruction are needed for students with SEBD in particular.

Both teacher-directed and mixed student-teacher directed IBL generally seem to work well for students with disabilities, as working with ‘hands-on’ materials seems most important to fulfill students’ needs to ‘experience’ the materials themselves (e.g., Brusca-Vega et al., 2011; Camenzuli & Buhagiar, 2014; McCarthy, 2005; Taylor et al., 2018). Yet, incorporating room for students to make decisions during the IBL activities seems to increase the level of student motivation and engagement even more (e.g., Bargerhuff, 2013; Brusca-Vega et al., 2014). Teachers apply multiple types of teacher guidance during IBL activities – especially the more specific types (e.g., direct instruction/explanations, scaffolds, heuristics, and prompts). They focus on concepts, procedures, and social processes in parallel, to suit the various social-emotional and academic needs of their students. Less guidance seems to relate to specific problems, such as fewer opportunities to learn specific inquiry skills (Abels, 2014) and generalization problems (Rapp, 2005).

Regarding differentiation, it appeared that teachers proactively adjusted their teaching methods and students’ learning activities most often to students’ needs in order to maximize individual students’ and classroom learning – both for students with disabilities in general and for students with SEBD specifically. Differentiation in curricula, resources and student products were less often applied. On the one hand, this could indicate that differentiation in these three dimensions could provide opportunities to adjust IBL instruction even more to the specific population of students with SEBD. On the other hand, this could also indicate that teachers find it challenging to differentiate – which has been found in other studies as well (e.g., Coubergs, Struyven, Gheysens, & Engels, 2015; Prast, Van de Weijer-Bergsma, Kroesbergen, & Van Luit, 2015). Regardless, it seems necessary for teachers to combine both subject-specific expertise with population-specific expertise to suit the various social-

emotional and academic needs of students with SEBD during IBL instruction, and this seems a very demanding task for teachers.

Notably, with regard to teacher differentiation, many adjustments were made in the area of language and literacy demands. For instance, teachers read out loud texts and assignments (e.g., Brusca-Vega et al., 2011) and used visualizations (e.g., Abels, 2014; Palincsar et al., 2001) and actively taught students various strategies that support them in this area (e.g., literacy-strategies and mnemonic strategies) (Abels, 2014; Brusca-Vega et al., 2014). In addition, students engaged in ‘hands-on’ activities to learn substantive content (e.g., Mastropieri et al., 2006; McCarthy, 2005), and they were allowed to use multimodal representation (drawings, writings, demonstrations or oral presentations) to show subject understanding in response to assignments (e.g., Brusca-Vega et al., 2014; McCarthy, 2005; Taylor et al., 2018). These adjustments resulted in fewer language and literacy demands on students in comparison with traditional methods (Parmar et al., 1994), and thereby seem to fulfill the need of students with SEBD to use other modes of learning than reading/listening and to ‘experience’ the substantive content themselves. Consequently, students seem to be more engaged, tend to show more appropriate classroom behavior, and learn more, as has been found in other research showing that a focus on academic instruction for students with SEBD is often accompanied by non-academic behavioral improvements (Lane, 2004; Van der Worp-van der Kamp et al., 2014).

Student outcomes in terms of knowledge, skills, attitudes and behavior were often reported as average scores of very heterogeneous groups, comprising students with various disabilities. The predominant student outcomes included significant achievement gains over time, both when measured quantitatively (e.g., Camenzuli & Buhagiar, 2014; Mastropieri et al., 2006) and qualitatively (e.g., Belland et al., 2006; Brusca-Vega et al., 2011), and qualitative improvements in classroom behavior (e.g., Belland et al., 2006). Even though this

is in line with research among students with SEBD, indicating that a focus on academic instruction is often accompanied by non-academic behavioral improvements (also see Lane, 2004; Van der Worp-van der Kamp et al., 2014), from the currently published research, it is difficult to pinpoint which results relate to students with various disabilities or to students with SEBD specifically. Yet, IBL instruction seems a promising method to achieve learning goals in various domains – also for student groups with various special educational needs.

Reflections and Recommendations for Future Research

The results of our study show that research in the field of inquiry-based learning for specific student populations – and students with SEBD in particular – is in its infancy. It was only possible to include relatively few studies in our systematic review, resulting in anecdotal evidence at most. The field of IBL for specific student populations thus deserves further empirical study.

In addition, the majority of the research appeared not to focus on specific diagnostic labels. Conclusions from these papers mainly related to students with disabilities in general – a population that is very heterogeneous by definition. This may reflect reality in educational practice, in which classrooms comprise an increasingly diverse student population. Consequently, a promising line of research would be to examine the needs of educational practice regarding research in this field. That is, students with various disabilities face difficulties in collaborating with peers during small group work, but some of these difficulties stem from cognitive disabilities (e.g., lack of understanding), from internalizing problems (e.g., anxiety to contribute to the group conversation), or from externalizing problems (e.g., starting conflicts when things do not go the student's way). It could be helpful for teachers to know how to support students showing different behaviors during IBL instruction in an inclusive classroom, instead of trying to investigate what works for students with various diagnostic labels. Yet, it is most important that follow-up research is done in a bottom-up

process in which educational practice is consulted first, such that research results can be directly applied in the classroom.

Another promising line of research would be to examine the learning processes of students in the various phases of the IBL context. More specifically, one would focus on questions such as “What do they learn?”, “When do they learn?”, and “How do they learn?”. Knowledge about the underlying learning processes during IBL instruction will render recommendations with regard to the specific ways to support students with various disabilities during the various phases and activities that IBL instruction entails.

All but two empirical studies, and all but two discussion-based articles were concentrated on the United States. The majority of this U.S.-based research was conducted by two research groups. Their pioneering work in this research field laid the ground for further research in the field of inquiry-based learning for specific student populations. Yet, this research may provide a relatively one-sided picture of the use and adjustments of IBL instruction for students with SEBD – especially given that education for students with special educational needs is organized differently in various countries (Meijer, 2001, 2003; OECD, 2016). Future research would benefit from studies in countries with a larger spread across the world.

The included studies showed that more work is needed to overcome risk of bias in this field. In our study, there were no specific bottlenecks with regard to the various risk of bias criteria. This relatively diffuse pattern indicates room for improvement of the quality of research on various aspects. The instruments used to assess risk of bias in this study are rather strict, rendering it difficult to fulfill all scientific criteria, especially given that the majority of the included articles concerned practice-based research. One main reason for the relatively high risk of bias might be difficulty to define a clear research population. That is, inclusive classrooms comprise students with various disabilities (and various comorbid problems), and

it is therefore challenging to clearly operationalize student outcomes when adjustments often need to be made in response to students' needs. The use of checklists for risk of bias, such as the Quality Assessment Tool for Quantitative Studies (NCCMT, 2008) or CASP criteria (CASP, 2018), may provide researchers with valuable insights into how more convincing research results can be produced, ultimately leading to stronger evidence-led practice.

Strengths and limitations

One of the strengths of our study was that we used a systematic strategy for our review in accordance with the PRISMA statement (Liberati et al., 2009; Moher et al., 2009), which we specified in advance. Although proving challenging to exactly follow this strategy, it provided us with important insights based on a systematic approach of the data.

Our study is, however, limited by the strict inclusion criteria used. That is, in order to keep our focus mainly on IBL instruction, we did not include related instructional methods in our systematic review, such as problem-based learning and project-based learning. Regardless of the strictness of the inclusion criteria used, our results provide a systematic overview of what is known about the suitability of IBL instructional methods for students with disabilities, and students with SEBD specifically. The specific examples of IBL activities and adjustments that are described in terms of teacher guidance and differentiation, can be directly applied in the classroom.

Implications for practice

The current study shows that IBL instruction is a promising method to achieve learning goals in various domains, provided that the teacher supports the students' various social-emotional and academic needs. Students with disabilities who receive IBL instruction make significant achievement gains over time (e.g., Brusca-Vega et al., 2011; Mastropieri et al., 2001, 2006; McCarthy, 2005), as their experiences with 'hands-on' materials during IBL seem to suit their educational needs better compared to traditional textbook and lecture-based

instruction. In addition, students with disabilities seem to be socially embedded in the classroom and participate in small group learning activities (e.g., Belland et al., 2006; Zembylas & Isenbarger, 2002). To this end, their social position in the classroom is supposedly strengthened. That is, students whom often would have been excluded were now participating in learning activities in inclusive classrooms with their typically developing peers (e.g., Brusca-Vega et al., 2011; Zembylas & Isenbarger, 2002). Both these outcomes are in line with the goals that are set for education to increase the learning outcomes of students with disabilities and to strengthen the social cohesion and social participation of specific student groups in the classroom (e.g., Ministry of Education, Culture, and Science, 2014; United Nations, 2006). In addition, IBL instruction provides teachers with various possibilities to adjust their education to various students' needs. That is, the open character of IBL instruction allows for numerous possibilities to adjust, for instance, substantive topic, level of difficulty of the task, type of learning activity, and group composition. To this end, teachers can differentiate at the outset of IBL activities and/or as adaptive responses to various students' difficulties and needs – regardless of their diagnostic labels.

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