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Fostering cognitive and affective-motivational learning outcomes for high-ability students in mixed-ability elementary classrooms: a systematic review

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Abstract
Since there has been no clear overview of educational practices that benefit high-ability students in mixed-ability classrooms in grades one to six, this review aims to provide insight into the effects of educational practices on the cognitive and affective-motivational learning outcomes of high-ability students. In order to identify these educational practices, we conducted a review of the existing literature, comprising a systematic search of the Education Resources Information Center and Web of Science databases for studies from the last 25 years. Only empirical studies that investigated the impact of interventions were included. Applying these criteria resulted in the inclusion of seventeen studies. Four different educational practices were shown to have a positive impact on cognitive learning outcomes: providing dynamic feedback, enhancing self-regulated learning, adjusting the curriculum and providing differentiated instruction. The impact of educational practices on affective-motivational learning outcomes was inconclusive. Based on this review, we conclude that teachers can help high-ability students in mixed-ability classrooms in grades one to six across various educational contexts using the educational practices reported in this study.

Keywords High-ability students · Educational practices · Elementary education · Systematic review · Student learning

Since the 1980s, international research on high-ability (HA) students has increased (Kulik & Kulik, 1984). We define HA students as students who excel in the intellectual (or cognitive) domain (Gagné, 2004; Heller et al., 2000; Renzulli, 2005). In the USA, in particular, a significant knowledge base has been developed and various programmes for HA students have been implemented in the education system. As there is a trend in (mainstream)

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education towards improving and adapting the learning environment as much as possible to the individual needs of diverse learners, this topic of research is becoming increasingly important (Amor et al., 2019; Van Mieghem, et al., 2018). It is especially important in elementary education to meet the needs of HA students to prevent loss of motivation, as this can have a negative effect on their further school careers (Snyder & Linnenbrink-Garcia, 2013; Vu et al., 2021). First- to sixth-grade classrooms are typically more heterogeneous in terms of cognitive ability than classes of older students. Most existing studies recommend part- or full-time separation, such as pull-out or accelerated programmes, in which HA or gifted students are instructed in a setting outside the classroom (Bailey et al., 2012; García-Martínez et al., 2021; Jen, 2017; Kim, 2016; Steenbergen-Hu et al., 2016). Although cognitive learning outcomes are often the main focus, many of the existing review studies report one or more positive effects on the social and emotional development of HA students. Research has continued to suggest that the affective and motivational aspects of learning can be beneficial for HA students' cognitive development (Gagné, 2004; Siegle & McCoach, 2005), emphasising the importance of gaining insight into both the cognitive and the affective and motivational learning outcomes. Compared to these specific programmes, less is known about the effectiveness of educational practices implemented in regular mixed-ability classrooms for cognitively gifted and HA students. Thus, it remains unclear which educational practices can challenge and stimulate HA students in mixed-ability classrooms. This review aims to fill the gap in the literature by systematically exploring the effects of educational practices implemented in mixed-ability first- to sixth-grade classrooms on the cognitive and affective-motivational learning outcomes of HA students.

Theoretical framework

High-ability students

Assumptions about and the criteria for 'giftedness' differ according to the theoretical model employed (Gagné, 1985, 2004; Heller et al., 2000; Renzulli, 1999; Siegle & McCoach, 2005; Subotnik et al., 2011). Across all models, HA students are those who excel in a certain domain. Since the intellectual (or cognitive) domain is considered important in education, in this review, we focus on giftedness in the cognitive domain (Gagné, 2004; Heller et al., 2000; Renzulli, 2005). Theoretical and empirical studies consider different non-cognitive personal and environmental factors to be important for developing high ability into outstanding mastery. For example, students with high self-regulation skills and high levels of autonomous motivation tend to show higher achievement (Reis & McCoach, 2000; Snyder & Wormington, 2020). Although different terms are in use (Dai & Chen, 2013), recent research often uses the term 'high-ability students' (Barbier, et al., 2022; Miller & Neumeister, 2017) to refer to students who have the cognitive ability to reach the highest levels of academic success (Dare et al., 2019). There is no clear cut-off in terms of scores on measurements of cognitive ability; they range from the top 20% to the top 1% (Gagné, 2004; Renzulli, 2005; Terman, 1925). From here on, we will use the term 'HA students'.

HA students significantly differ from their non-HA peers on certain cognitive aspects. First, HA students tend to have an excellent memory and can recall knowledge more efficiently than their typical peers (Aubry et al., 2021; Giofrè et al., 2013; Rodríguez-Naveiras et al., 2019). Also, they can process information faster (Paz-Baruch et al., 2014; Spiegel & Bryant, 1978). Additionally, research points out that HA students are better at solving problems than their peers and can use various strategies to do so (Abdulla Alabbasi et al., 2021). Furthermore, they generally demonstrate better higher-order thinking skills, including critical thinking (Kettler, 2014). In addition to these shared (meta)cognitive characteristics, HA students show differences in motivation, interests, personality, and other non-cognitive characteristics that impact the development of outstanding ability into performance at school (Gagné, 2004).

Since HA students differ from average students, it is important to consider their advanced cognitive skills and related needs. To develop their abilities and skills, HA students need a stimulating, motivating and challenging learning environment that takes into account the variety of their needs. Teachers play an important role in creating such an environment. Because student performance is the result of the interaction between individuals and their environment (Gietz, 2011; Lewin, 1963), a lack of fit can lead to motivational problems and underperformance (Barbier, et al., 2022; Snyder & Linnenbrink-Garcia, 2013). Teachers thus have a responsibility to create an appropriate learning environment, also for HA students. Therefore, it is relevant to look into evidence-based educational practices that benefit HA students.

Effective educational practices

Numerous theoretical and instructional models in the domain of learning and instruction elaborate on educational practices that are effective in enhancing student motivation and achievement (De Corte, 2013; Deci & Ryan, 2002; Pintrich, 2003; Tomlinson et al., 2003). Some models are broad and applicable to all students; for example, all students need to feel in control of their own behaviour (Deci & Ryan, 2002). Others take into account students' different needs; for example, instruction should always 'be in advance' of a student's current level of mastery (Tomlinson et al., 2003) or focus on creating empowering learning environments; for example, self-regulation can help HA students become competent (De Corte, 2013; Pintrich, 2003).

Based on previous studies on educating HA students, we have some understanding of effective educational practices. A meta-analysis by Kim (2016) showed the positive effects of summer and after-school enrichment programmes on the academic achievement and socio-emotional development of gifted students. A great deal of research has also explored the effect of grouping students (e.g. in homogeneous groups outside the regular mixed-ability classroom or cross-year groups) and found that it results in positive learning outcomes for HA students (Kulik & Kulik, 1992; Steenbergen-Hu et al., 2016). In the research on gifted students and gifted pedagogy, there are many recommendations for such classes (VanTassel-Baska, 2008). In terms of accelerating the curriculum, research has demonstrated the positive effects of allowing students to skip a course or grade (Kulik & Kulik, 1984; Steenbergen-Hu et al., 2016). Little et al. (2007) identified five principles for educating gifted and talented students based on theoretical and scientific research: daily challenge, the opportunity to work on personal talents, accelerating the subject matter, an adapted curriculum and the possibility of social interaction with talented peers. A review conducted by Rogers (2007) formulated similar 'lessons learned' for educating gifted students. However, there was no clear quality check of the empirical studies included. A recent review study by García-Martínez et al. (2021) on educational interventions with HA students included a range of effective interventions, most of which took place outside the mixed-ability classroom (e.g. acceleration or pull-out enrichment programmes).

The current study

Keeping in mind that previous studies provide little insight into educational practices for HA students in regular mixed-ability elementary classrooms, this review aims to contribute to the field. By focusing on intervention studies, we aim to identify 'what works' for HA students in mixed-ability classrooms in grades one to six.

The research questions are as follows.

1. Which educational practices for HA students have been examined in mixed-ability first- to sixth-grade classrooms?
2. What are the effects of these educational practices on cognitive learning outcomes?
3. What are the effects of these educational practices on affective-motivational learning outcomes?

We use 'student learning outcomes' as an umbrella term to refer to many different aspects of learning, such as cognitive, metacognitive and affective-motivational learning outcomes. Cognitive outcomes are defined as the development or acquisition of cognitive competencies in one or more academic fields (Gagné, 2004). Metacognitive outcomes include the development of views and beliefs about learning, the formulation of learning objectives and the attempt to monitor, regulate and control cognition, motivation and behaviour (Pintrich, 2000; Vermunt, 1996). Affective-motivational outcomes include aspects such as motivating, judging or evaluating oneself and experiencing emotions (Vermunt & Donche, 2017; Vermunt, 1996). These affective-motivational outcomes are important catalysts for the developmental processes of HA students (Gagné, 2004).

Methodology

Search

In the first phase, the search was restricted to peer-reviewed articles in academic journals to ensure a minimum standard of quality. We systematically entered search terms into two databases: the Education Resources Information Center (ERIC) and Web of Science (WoS), which includes the Social Sciences Citation Index, the Science Citation Index Expanded and the Arts & Humanities Citation Index. In addition to search terms concerning the research population ('high-ability', 'gifted', 'high-achieving'), search terms relevant to educational practices were added ('instruction', 'intervention', 'differentiation', 'teaching strategy'). Second, we included terms related to (meta-)cognitive learning outcomes ('achievement', 'learning') and affective-motivational learning outcomes ('motivation', 'engagement', 'well-being'). Combining the different search terms using Boolean terms (e.g. 'high-ability OR gifted OR high-achieving) AND instruction AND achievement') resulted in twenty search queries.

Selection

To ensure the reproducibility and transparency of the review process, the selection procedure will be described in accordance with the PRISMA flow diagram (Moher et al., 2009) (Addendum 1). The year of publication was limited to the last twenty-five years (1996–2021). This was imposed to ensure that the research was not too far removed from current classroom contexts. The search yielded 3563 empirical articles. After removing duplicates, 1754 articles remained. In the second phase, we reduced and refined this set of articles by reading their titles and abstracts. Three researchers each screened a different set of articles based on inclusion and exclusion criteria (see Table 1). To ensure the trustworthiness and the validity of the screening, several meetings were organised to address all questions that emerged during coding. When an article did not meet one or more of the criteria, it was excluded (see Table 1). This selection procedure yielded 129 articles. In the third phase, two researchers read the full articles, critically assessing their relevance and methodology. In doing so, we considered the main criteria developed by Aveyard (2014) and that of the CASP-tool (CASP, 2018). Thus, each study had to have (1) a well-specified research question, aim or hypothesis; (2) a well-described subject sample; (3) a well-described procedure for collecting data, with a clear focus on cognitive and/or affective-motivational learning outcomes; (4) a clear description of the intervention in the classroom (studies could have a control [no intervention] group and a follow-up measurement, but these were not required) and (5) a clear description of the findings. A more specific description of these criteria is given in Addendum 2. We did not include any review studies that reported on findings from a secondary source. There were minimal disagreements between the researchers in this phase. The small disagreements concerned the results of the studies (e.g. if the effect on HA students compared to other students was sufficiently clear). The first author made the final selection, with the agreement of the co-authors. Upon completion of this phase, 17 articles remained, each reporting on a different study.

Table 1 Inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
Sample	Grades 1–6	Kindergarten, secondary education, higher education
	HA students	Twice-exceptional students (e.g. HA students with autism)
Intervention	Teaching practices in mixed-ability classrooms	Teaching practices in part- or full-time ability groupings outside the mixed-ability classroom or school
Outcome	Impact on the cognitive and affective-motivational learning outcomes of HA students	Impact on parents or teachers

Analysis of the literature

First, the general characteristics of the studies were identified (see Addendum 3). This analysis indicated various similarities and differences and offered possibilities for clustering the studies based on different perspectives: context (country and classroom), age, sample, definition of HA students and identification of the research participants. The ages of the participants ranged from six to thirteen. HA students were defined and identified differently in each study. Terms used included 'HA students', 'high-achievers', 'advanced readers', 'potential gifted', 'gifted students' and 'highly-intelligent students'. In most of the studies, a cognitive ability test or a standardised math test was used to identify these students. In some studies, the nomination of HA students by teachers or parents was taken into account. Most of the studies were conducted in the USA or Europe and focused on a specific course such as mathematics or language. Second, we looked into the different educational practices (see Table 2). Thematic analysis was used to interpret the data. Next, inductive coding was applied to provide an overview of the educational practices used in the different studies. Cognitive and/or affective-motivational learning outcomes were taken into account in the analysis. Although qualitative research was not excluded beforehand, only three studies opted for mixed-methods research; all the others were quantitative. All studies applied a pre- and post-test design; twelve included a control group (who did not receive the intervention), which indicates that they were high-quality intervention studies. In order to interpret the results, Cohen's (1988) rule of thumb was followed: Effects were identified as small, medium or large. The number of participants ranged from 20 to 3514 students (not all were HA students), and interventions lasted between 90 min and 5 years. In sixteen studies, teachers received training so that they became experts in the intervention; this enhanced the implementation fidelity.

Results

Educational practices

Table 2 presents an overview of the different educational practices implemented for HA students in mixed-ability first- through sixth-grade classrooms and their effect on cognitive and/or affective-motivational learning outcomes. We distinguish five different ways educational practices were applied to foster positive learning outcomes for HA students.

First, three studies (Popa & Pauc, 2015; van Dijk et al., 2016; Vogelaar et al., 2019) focused on the use of 'dynamic feedback' or 'dynamic assessment'. These interventions consisted of prompting students during class by giving them hints or feedback. The goal was for students to become more competent in autonomously analysing their learning processes and errors.

Second, three studies (Obergriesser & Stoeger, 2015; Sontag & Stoeger, 2015; Stoeger & Ziegler, 2005) focused on self-regulated learning. The teachers reflected on various topics with their students, such as time management, how they studied at home and how to set goals. They gave tips and exercises related to cognitive and metacognitive strategies. The goal of this study was to enhance students' competence in self-regulated learning.

Third, four studies (McCoach et al., 2014; Reis et al., 1998; Robinson et al., 2014; VanTassel-Baska et al., 2002) explored the impact of adjusting the curriculum. They either focused solely on enrichment (e.g. providing more challenging tasks; stimulating

Table 2 Description of the educational practices and their impact on the cognitive and/or affective-motivational learning outcomes of HA students

Study and country	Methodology	Intervention	Impact on cognitive learning outcomes	Impact on affective-motivational learning outcomes
Dynamic feedback				
Popa and Pauc (2015), Romania	8 weeks; 50 students, including potentially gifted students and others, no other specifications; ages 6–7; quantitative; pre- and post-test; control group (no intervention)	Effect of dynamic assessment on cognitive achievement. All interventions included clarification of types of errors, explaining alternative ways of solving tasks and encouraging students to become more autonomous in analysing their own task-solving processes and errors. Collective prompts and feedback dominated the plan of intervention	Dynamic assessment stimulated greater cognitive achievement for HA students than students from the control group (Cohen's $d = 0.81$, large effect size for all students in the treatment group) *Measurement*: traditional static achievement tests designed by researchers	NI
van Dijk et al. (2016), the Netherlands	1 session (90 min); 478 students, 95 of whom were HA; ages 9–13; quantitative (pilot study); pre- and post-test; control group (no intervention); retention test (one month later)	Impact of giving students hints during research-focused tasks on their learning progress	Making hints available had a positive effect on the learning process of HA students ($\eta_p^2 = 0.35$, large effect size). There was no effect on performance *Measurement*: log files, domain knowledge test	Prompts had no effect on the motivation of HA students *Measurement*: motivation questionnaire
Vogelaar, et al. (2019), the Netherlands	6 weeks; 148 students, of whom 50 were gifted students; ages 9–10; quantitative; pre-and post-test; control group (no dynamic training)	Impact of dynamic testing on the learning outcomes of HA students. Students in the treatment group received dynamic training (graduate prompts technique)	All students (including HA students) improved significantly ($\eta_p^2 = 0.1$, medium effect size) *Measurement*: dynamic test of analogical reasoning (20 visual-spatial geometric analogies)	NI

Table 2 (continued)

Study and country	Methodology	Intervention	Impact on cognitive learning outcomes	Impact on affective-motivational learning outcomes
Enhancing self-regulated learning				
Obergriesser and Stoeger (2015), Germany	7 weeks (daily basis); 85 HA students, including 24 gifted underachievers and 61 gifted achievers; ages 10–11; quantitative; pre- and post-test; control group (no intervention); weekly scores of learning behaviour during the first five weeks	Impact of self-regulated learning on learning behaviours (such as text-reduction strategies, competence in identifying main ideas and self-assessment/monitoring), self-efficacy and anxiety	Positive intervention effect for both gifted achievers and underachievers on text-reduction strategies (partial $\eta^2 = 0.2$, large effect size). Students' competence in identifying main ideas and self-assessment increased (no effect size). Only underachievers increased in strategy monitoring over time (no effect size) *Measurement*: e.g. questionnaire, rating text-reduction and main ideas	Slight indication of improvement in self-efficacy among underachievers (partial $\eta^2 = 0.04$, small effect size) No intervention effects on anxiety *Measurement*: questionnaire

Table 2 (continued)

Study and country	Methodology	Intervention	Impact on cognitive learning outcomes	Impact on affective-motivational learning outcomes
Sontag and Stoeger (2015), Germany	7 weeks; 322 students, of whom 29 were highly intelligent and 20 high-achieving; ages 9–10; quantitative; pre-and post-test; control group (no intervention); weekly scores of learning behaviour during the first five weeks	Effect of self-regulated learning- programme (such as text-reduction strategies, self-assessment, goal setting and strategic planning) on average scholastic achievement (reading comprehension)	Preferences for self-regulated learning: General effectiveness of self-regulated learning training for HA students. High achievers had an increased preference for self-regulated learning immediately after the training ($d = 0.44$, small effect size) and in the long term ($d = 0.82$, large effect size). Highly intelligent students experienced long-term effects ($d = 0.5$, medium effect size) Reading comprehension: There was a highly significant increase in the comprehension of main ideas among high achievers and highly intelligent students. ($d = 0.93$; 0.63, medium-to-large effect size) *Measurement:* questionnaire, rating main ideas	NI
Stoeger and Ziegler (2005), Germany	6 weeks; 36 HA students; age 10; quantitative; pre-and post-test; control group (no intervention)	Effect of self-regulated learning-programme (time management, self-reflection, goal-orientation) on the learning progress	No significant effect on cognitive performance. Slight improvements on time management (no clear effect size) *Measurement*: scholastic test, questionnaire	For motivation, as in persistence in the face of challenging objectives, no statistically significant increase was found. There was a significant positive effect on helplessness and self-efficacy (no clear effect size) *Measurement*: questionnaire

Table 2 (continued)

Study and country	Methodology	Intervention	Impact on cognitive learning outcomes	Impact on affective-motivational learning outcomes
Adjusting the curriculum				
McCoach et al. (2014), USA	16 weeks; 2290 students including 332 high achievers; ages 8–9; quantitative; pre- and post-test; control group (no intervention)	Effect of adjusted research-based differentiated curriculum (enrichment) on learning	The research-based differentiated curriculum had a positive effect on the highest achieving students (Cohen's $d=0.41$, small effect size). Especially high-achieving students in lower-achieving schools benefited the most *Measurement*: Iowa Tests of Basic Skills, Math Problem and Data Interpretation tests and unit tests	NI
Reis et al. (1998), USA	1 year; 336 HA students; ages 7–12; quantitative; pre-and post-test; control group (no intervention)	Effect of curriculum compacting and replacement on achievement on a standardised test	Compacting and replacing had no effect, meaning that 40–50% of the curriculum can be eliminated without causing a decline in students' achievement *Measurement*: Iowa Tests of Basic Skills	NI

Table 2 (continued)

Study and country	Methodology	Intervention	Impact on cognitive learning outcomes	Impact on affective-motivational learning outcomes
Robinson et al. (2014), USA	2 years; 157 gifted students; ages 7–11; quantitative; pre-and post-test; control group (no intervention); four tests	Effect of Science, Technology, Engineering, and Mathematics (STEM) interventions (a rich problem-based inquiry curriculum) on cognitive achievement	HA students in the problem-based learning environment scored better on the post-test than those in the control group: student science process skills ($\eta^2 = 0.12$; $\omega^2 = 0.08$; medium effect size), student knowledge of science content and concepts ($\eta^2 = 0.3$; 0.4; $\omega^2 = 0.72$; 0.39, large effect size) *Measurement*: assessment that included problem-based, open-ended questions and curriculum-based assessment	NI
Van Tassel-Baska et al. (2002), USA	5 years; 2,189 gifted students, 2 groups (152 and 160) of whom were in a heterogeneous classroom; ages 7–14; quantitative; pre- and post-test; control group (no intervention)	Effectiveness of a curriculum in which literary analysis and interpretation and persuasive writing are taught as language arts manifestations of higher-level thinking	Strong gains for students in literary analysis and interpretation and writing compared to HA students in the control group ($\eta^2 = 0.07$; 0.24, medium-to-large effect size). Significant gains in all grouping models, including cluster-grouped heterogeneous classes *Measurement*: reading and writing test	NI

Table 2 (continued)

Study and country	Methodology	Intervention	Impact on cognitive learning outcomes	Impact on affective-motivational learning outcomes
Grouping				
Lee et al. (2019), USA	14 weekly activities (60 min each); 20 students, including 10 HA students; average age = 10.75; mixed-method; pre- and post-test; control group (no intervention, individual work)	Effect of online collaborative writing (heterogeneous pairing) on writing skills	Skilled writers in the control group (working individually) improved more than those in the experimental group (no effect size) *Measurement*: assessment of writing fluency, story elements, writing mechanics and higher-order thinking	NI
Saleh et al. (2005), Kuwait	9 weeks; 104 male students, of whom 29 were HA students; ages 9–10; quantitative; video; pre-and post-test; heterogeneous vs homogenous groups	Effect of homogeneous vs heterogeneous grouping on test scores	Grouping had no effect on the cognitive performance of HA students *Measurement*: achievement test and collaborative learning assignment	Grouping had no effect on the motivation of HA students *Measurement*: questionnaire
Differentiated instruction				
Faber et al. (2018), the Netherlands	16 lessons; 953 students, including 314 HA students; ages 7–8 and 10–11; quantitative; observations; ICALT (International Comparative analysis of learning and teaching); pre- and post-test	Data-based decision making (DBDM): effect of homogeneous grouping and adapted instruction (compacting) on cognitive performance	No significant effect of DBDM on performance *Measurement:* CITO standardised test	NI

Table 2 (continued)

Study and country	Methodology	Intervention	Impact on cognitive learning outcomes	Impact on affective-motivational learning outcomes
Guthrie et al. (2009), USA	12 weeks; 156 students, including 40 HA students; ages 10–11; quantitative; pre- and post-test; control group (no intervention)	Effect of Concept Oriented Reading Instruction (CORI) (choice, relevance, success, collaboration, thematic units, fluency instruction, fix-up strategies) on six learning outcomes. Low achievers received explicit instructions from the teachers	Positive effect of CORI reading strategies on the reading comprehension, word recognition and domain knowledge of HA students (unclear effect size). No effect on fluency *Measurement:* reading test, knowledge-, fluency- and inference assessment, word recognition and reading fluency	No effect on motivation *Measurement*: questionnaire, but not all items were used, which may have led to a less valid measurement of internal motivation for reading

Table 2 (continued)

Study and country	Methodology	Intervention	Impact on cognitive learning outcomes	Impact on affective-motivational learning outcomes
Hunsaker et al. (2010), USA	3 years; 211 advanced readers; ages 9–12; mixed method; pre- and post-test; literature analysis; interviews; observations	Effect of six teaching strategies: (1) identification of advanced readers; (2) organisation for instruction (e.g. creating time for advanced reading-related curriculum); (3) content (e.g. selecting curriculum content for advanced readers based on their profiles of strengths, interests, etc.); (4) instructional strategies (e.g. using strategies that apply comprehension and inquiry skills that broaden and deepen knowledge beyond what is normally required for the grade level); (5) continuous improvement assessment (e.g. providing formative data on advanced readers' growth); (6) ambassadorship for the Project (e.g. explaining the project to others such as parents)	Implementation of the six strategies by the teacher was directly related to improvements on the literature analysis test ($r=0.19$, small effect size) *Measurement*: observations and interviews of teachers implementing teaching strategies; pre- and post-literature analyses for students	Overall, teacher implementation of the six strategies was related to changes in choice ($r=0.16$) and enjoyment ($r=0.17$) (small effect size) *Measurement*: observations and interviews of teachers implementing teaching strategies; questionnaire 'My Class Activities'

Table 2 (continued)

Study and country	Methodology	Intervention	Impact on cognitive learning outcomes	Impact on affective-motivational learning outcomes
Maker et al. (1996), USA	1 year; 46 students, including 8 gifted students; ages 6–8; mixed-method; pre-and post-test; problem-solving assessment; interviews; observations	DISCOVER project: (a) development of multiple intelligences; (b) solving problems with varied structures; (c) active, hands-on learning with the tools of the seven intelligences; (d) integration of the culture and language of the students and the community; (e) curriculum planning around abstract themes	With a high-level implementer (teacher), all gifted students made gains in problem-solving skills. Six additional students were categorised as gifted in the post-assessment. With a middle-level implementer (teacher), only 3 out of 5 gifted students made gains in problem-solving. Three other students were categorised as gifted in the post-assessment. (no effect size) *Measurement*: problem-solving assessment	NI
Prast et al. (2018), the Netherlands	2 years; 3514 students in the first year, of whom 1225 were high-achieving students; 3473 students in the second year, of whom 1285 were high-achieving students; ages 6–12; quantitative; pre-and post-test; retention test in the second year; control group (no intervention)	Cycle of differentiation: (1) identification of students' current skills and division of students into homogeneous groups; (2) differentiated goals for each group; (3) differentiated instruction for each group; (4) differentiated practice tasks for each group	Year 1: cycle of differentiation had a positive effect ($\beta = 0.12$, small effect size) on HA student achievement in mathematics Year 2: cycle of differentiation had no effect on HA student achievement in mathematics, neither short-term nor long term *Measurement*: Cito Mathematical Test, non-verbal intelligence test (Raven Standard Progressive Matrices), working memory test	NI

NI, not included; *HA*, high-ability

higher-order thinking skills) or combined it with compacting (e.g. skipping unnecessary or repetitive and exercise material) and/or problem-based inquiry. The interventions were designed for the whole class and thus included HA students in the treatment group. The degree of compacting varied according to the students' ability level. The goal of these interventions was to enhance the learning and achievement of (HA) students.

Fourth, two studies (Lee et al., 2019; Saleh et al., 2005) examined the impact of homogenous and heterogeneous grouping on the learning of HA students. Saleh et al. (2005) focused on within-class grouping, both homogeneous and heterogeneous. Lee et al. (2019) designed an online collaboration, creating heterogeneous pairs of students from different schools.

Finally, five studies used differentiated instruction, involving a combination of educational practices (Faber et al., 2018; Guthrie et al., 2009; Hunsaker et al., 2010; Maker et al., 1996; Prast et al., 2018). Each study used a specific instructional strategy or programme, respectively labelled 'DBDM' (Data-Based Decision Making), 'CORI-reading strategies' (Concept Orientated Reading Instruction), 'Project ARAR' (Advanced Readers At Risk), the DISCOVER project and the 'cycle of differentiation'. As shown in Table 2, the studies used varying forms of differentiated instruction. Faber et al. (2018) used within-class ability grouping and differentiated instruction. Guthrie et al. (2009) implemented motivational practices along with Concept Oriented Reading Instruction. This included giving HA students choices, making the content relevant to students, providing texts in the zone of proximal development and teaching students how to monitor their own comprehension of a text. Hunsaker et al. (2010) focused on differentiation by carefully identifying students, preparing adapted instruction in terms of content, designing instructional activities for HA students and conducting ongoing evaluations. Maker et al. (1996) implemented different classroom teaching strategies and a curriculum based on the theory of multiple intelligences (Gardner, 1983), the principles of differentiation and the integration of culturally relevant content. Finally, Prast et al. (2018) used a 'cycle of differentiation': Teachers identified students' current skills and divided them accordingly into homogeneous ability groups. Afterwards, teachers set different goals and used different practices and forms of instruction to meet the needs of each group. The goal of these studies was to enhance the learning, achievement and/or motivation of the students.

Effects on cognitive learning outcomes

The majority of studies (eleven out of fifteen) found significant positive effects on the cognitive learning outcomes of HA students. The effect sizes varied from small to large (see Table 2).

First, providing dynamic feedback in the classroom had positive effects on cognitive learning processes and/or outcomes (Popa & Pauc, 2015; van Dijk et al., 2016; Vogelaar et al., 2019). Two studies (Popa & Pauc, 2015; Vogelaar et al., 2019) found that dynamic assessment enhanced cognitive learning outcomes for all students, including HA students. Although van Dijk et al. (2016) did not find a significant effect on HA students' learning outcomes, they did find a positive effect on the learning process.

Second, two of the three studies focusing on improving self-regulated learning reported positive outcomes regarding the cognitive performance of HA students (Obergriesser & Stoeger, 2015; Sontag & Stoeger, 2015). One self-regulation programme (Stoeger & Ziegler, 2005) found no significant effect on the cognitive learning outcomes of HA students.

Third, mainly positive outcomes were found for approaches that adapted the curriculum. In the study by McCoach et al. (2014), enriching the curriculum for HA students had a small positive effect, especially in disadvantaged schools. In the study by Reis et al. (1998), the results indicated that the achievement tests scores of HA students whose curriculum was compacted (40–50%) did not differ significantly from those whose curriculum was not compacted. Curriculum compacting and enrichment thus did not harm HA students and was recommended to prevent boredom. In the study by VanTassel-Baska et al. (2002), the implementation of an advanced curriculum that stimulated higher-order thinking and concept development resulted in greater gains with regard to literary analysis, interpretation and writing in the intervention group than in the control group. The study including a curriculum centred on problem-based inquiry (Robinson et al., 2014) yielded positive findings, as HA students who followed this curriculum performed better on the post-test than the control group.

Fourth, the research on grouping by Saleh et al. (2005) found no differences between homogenous and heterogeneous within-class grouping for HA students. In the research by Lee et al. (2019) on heterogeneous pairing, HA students in the intervention group performed better than those in the control group who worked individually.

Finally, there were mixed but mostly positive outcomes in the four studies that focused on multiple educational practices. Faber et al. (2018) found no significant effects of the DBDM intervention, while Guthrie et al. (2009) found positive effects on some cognitive learning outcomes, but not on all measures (e.g. reading fluency). Regarding the ARAR approach (Hunsaker et al., 2010), this approach was positively correlated with improved literary analysis skills. The DISCOVER project mainly improved HA students' problem-solving skills when their teacher implemented the curriculum and the different instructional strategies correctly ('high implementer'). Moreover, the cycle of differentiation employed by Prast et al. (2018) yielded a positive effect on students' learning outcomes in the first year of implementation but had no effect in the second year.

Effects on affective-motivational learning outcomes

Six studies included affective-motivational outcome variables such as motivation, self-efficacy and enjoyment. When considering the different categories (using dynamic feedback, enhancing self-regulated learning, adjusting the curriculum, grouping and differentiated instruction), at least one study per category included an affective-motivational outcome measure except for using an adapted curriculum, for which only cognitive learning outcomes were reported.

First, providing dynamic feedback by prompting and giving hints had no significant effect on the motivation of HA students. Second, the studies that tried to enhance self-regulated learning included various affective-motivational measures (e.g. self-efficacy) and reported different effects. For instance, Obergriesser and Stoeger (2015) found no effect on the anxiety of HA students and only found an improvement in the self-efficacy of HA underachievers. Stoeger and Ziegler (2005) considered gifted underachievers and reported a significant effect on self-efficacy. The results suggest that, when considering the affective-motivational outcome of self-efficacy, improving self-regulated learning is mainly effective for underachieving HA students. Stoeger and Ziegler (2005) also found a positive impact on reducing helplessness and no effect on 'persistence when faced with challenging objectives'. Furthermore, regarding homogeneous or heterogeneous within-class grouping, no impact was found on motivation (Saleh et al., 2005). Finally, only one study that used multiple educational practices included measurements of affective-motivational learning outcomes, namely enjoyment (Hunsaker et al., 2010). In this study, small positive effects of using differentiated instruction on affective-motivational learning outcomes were found.

Conclusion and discussion

Compared to part- or full-time separation programmes for HA students, such as enrichment programmes (García-Martínez et al., 2021; Kim, 2016; Steenbergen-Hu et al., 2016), we know little about the effectiveness of educational practices implemented in mixed-ability classrooms for these students. To identify the impact of educational practices in first- to sixth-grade classrooms on the cognitive and/or affective-motivational learning outcomes of HA students, we conducted a systematic review of empirical studies investigating the impact of interventions.

First, we identified five within-class educational practices for HA students that have been studied in the past 25 years: using dynamic feedback, enhancing self-regulated learning, adjusting the curriculum, within-class grouping and providing differentiated instruction. These practices respond to the cognitive and non-cognitive characteristics and needs of HA students mentioned in the theoretical framework. For example, giving dynamic feedback ensures that HA students have opportunities to improve their inquiry skills (Abdulla Alabbasi et al., 2021). Furthermore, by compacting and enriching the curriculum and/or differentiating their instruction, teachers provide HA students with the chance to learn at a faster pace and develop higher-order thinking skills (Steiner & Carr, 2003). Also, enhancing self-regulation skills such as self-assessment, goal setting and strategic planning contributes to converting these students' cognitive ability into strong performance (Reis & McCoach, 2000). Moreover, in accordance with previous studies, grouping HA students together and providing them with more challenging work than their peers is a well-known effective educational practice (Steenbergen-Hu et al., 2016).

Second, regarding the effects of these educational practices on cognitive learning outcomes, many of them had positive effects, with effect sizes ranging from small to large. Positive effects were reported from providing dynamic feedback, enhancing self-regulated learning, adjusting the curriculum and using differentiated instruction. However, some studies showed no effect. Furthermore, effects also varied depending on the outcome measure and subgroup. We can state that adjusting the curriculum, providing dynamic feedback and enhancing self-regulated learning are most likely to be effective, given that the majority of studies, including those with large sample sizes, reported medium-to-large effect sizes. Adjusting the curriculum, in particular, was found to be effective in multiple large-scale studies. However, the use of differentiated instruction is supported by less empirical evidence since the study with the largest sample found that it had no effect and several studies did not report the effect size of their positive results.

Third, looking at the impact of the five identified educational practices on affective-motivational learning outcomes, the results were not straightforward. These practices either had no effect or varied effects, with mostly small effect sizes. A possible explanation is that affective-motivational effects only applied to certain subgroups in the measured samples. Enhancing self-regulated learning, for example, had a positive effect on self-efficacy and the reduction of helplessness, but only for underachieving HA students (Obergriesser & Stoeger, 2015; Stoeger & Ziegler, 2005). Besides these two studies, no other study included underachieving HA students (Reis & McCoach, 2000) as a subsample for separate analysis. As we know from the previous literature, underachievement is linked to various motivational problems (Snyder & Wormington, 2020; White et al., 2018). This review thus points out the relevance of including HA underachievers as a separate sample when studying the effect of educational practices in mixed-ability classrooms. A recent meta-analysis by Steenbergen-Hu et al. (2020) provides insight into the effectiveness of interventions specifically aimed at reducing underachievement among gifted students. We recommend further research on why some interventions work and the conditions under which they work.

It is important to interpret these findings with caution. For example, the homogeneous grouping has been shown to be effective for the cognitive learning outcomes of HA students in many studies (Kulik & Kulik, 1992; Rogers, 1993). Saleh et al. (2005), however, did not find that within-class grouping had a significant effect. In this study, both homogeneous and heterogeneous groupings were applied, but the authors did not make an explicit statement about curricular adjustments such as enrichment, compacting or acceleration. It is therefore unclear whether the insignificant effect was a consequence of grouping or how it was implemented. As Kulik and Kulik (1992) concluded, when grouping goes hand in hand with enrichment and acceleration, it has the greatest effect on student learning.

Furthermore, it is striking that fewer than half of the studies considered affective-motivational learning outcomes. Moreover, the studies that did include these outcomes identified a limited number of affective-motivational components (e.g. enjoyment). It would be valuable to consider other learning outcomes as well, such as goal valuation and behavioural, cognitive and emotional engagement. The framework adopted by Siegle and McCoach (2005) could inspire other researchers to examine affective-motivational learning outcomes more robustly.

There are some limitations to this research that need to be addressed. First, because few studies met the inclusion criteria, there was little similarity in the contexts and interventions of the various studies. Furthermore, the identification of HA or gifted students was different in every study. These differences in conceptualisation, along with the diversity of classroom contexts, did not allow us to conduct a quantitative meta-analysis. It is also important to recognise the impact of the educational contexts in which the studies were undertaken. For example, adjusting the curriculum was only studied in the USA, which has a different school system and pedagogy than countries in Europe. Therefore, it remains an important question whether the effectiveness demonstrated in these contexts will hold true in other educational contexts and cultures. Also, it is important to acknowledge that, due to the specific focus of this review, other interesting studies on educating HA students did not meet the inclusion criteria (e.g. interventions outside the mixed-ability classroom or studies with no clear reporting on the learning outcomes of HA students; Callahan et al., 2014; Gavin et al., 2013). Moreover, possible publication bias needs to be taken into account, as this literature search was limited to the databases ERIC and WOS. However, including unpublished or non-peer-reviewed studies also has disadvantages with regard to quality control.

In this review, there was a wide variety of intervention-type research designs, with numbers of participants ranging from 36 to 2290 (not all HA) and interventions lasting from 90 min to 3 years. To extend the generalisability of the educational practices found to be effective in this review, it would be useful to replicate these studies. Another interesting avenue for future research would be to focus on the duration required for educational practices to be effective for HA students. Future research could, for instance, monitor the learning progress of a large group of HA students and test the impact of educational practices adopted by their teachers. In addition, the results that emerged from this set of studies were mostly quantitative. We, therefore, argue for empirical qualitative research to investigate in greater depth how effective educational practices are experienced by HA students in their specific context in mixed-ability classrooms. In terms of practice, it is important to keep in mind that the effective educational practices we highlighted were based on studies conducted in specific educational contexts in different countries. We recommend that practitioners always start with the needs of a given group of students, class or school. It is also important to check whether the educational practice(s) match(es) the prior knowledge, skills and attitudes required. Therefore, we recommend that teachers explore whether (and why) these educational practices work in their classroom or school context. One way to do this is by conducting practical research with their colleagues – for example, via the method of Lesson Study (Dudley, 2019; Vermunt et al., 2019).

Based on this review, we conclude that for grades one to six across different educational contexts, teachers can support HA students in heterogeneous classrooms through the educational practices reported in this study: using dynamic feedback, enhancing self-regulated learning, adjusting the curriculum and providing differentiated instruction. This is an important finding for both in-service teachers and teachers-in-training. Teachers should be prepared for the diversity of students they will encounter in the classroom and understand possible ways to support HA students through evidence-based educational practices. Although some of the reported practices are clearly specific to educating HA students (e.g. compacting and enriching the curriculum), others are fairly common strategies in the literature on effective teaching (e.g. self-regulated learning; De Corte et al., 2004; Tomlinson, 2017). It is therefore important to keep in mind that at least some of the educational practices discussed in this review can be useful for all students.

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*References marked with an asterisk indicate studies included in the analysis.

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