

**DIRECTORATE FOR EDUCATION AND SKILLS
EDUCATION POLICY COMMITTEE**

E2030 CURRICULUM ANALYSIS: LITERATURE REVIEW ON THE IMPACT STUDY

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This draft is prepared by Joke Voogt, Nienke Nieveen, Henk Sligte, and Anne Lemmens as part of the background research commissioned by the OECD Secretariat based on the agreement of the Working Group of the participating countries in the project of the OECD Future of Education and Skills 2030.

The delegates are invited to:

- *COMMENT on the draft and DISCUSS relevance of the findings*
- *SUGGEST additional literature, if any, to be included in this study to ensure the global knowledge base on the impact study of curriculum redesign*

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E2030 CURRICULUM ANALYSIS: DRAFT LITERATURE REVIEW ON THE IMPACT OF CURRICULUM REDESIGN

Background

1. This draft is prepared by Joke Voogt, Nienke Nieveen, Henk Sligte, and Anne Lemmens as part of the background research commissioned by the OECD Secretariat based on the agreement of the Working Group of the participating countries in the project of the OECD Future of Education and Skills 2030.

2. The paper will be finalized after the 4th meeting of the Working Group, taking into account the comments and suggestions made by the delegates at the meeting as well as the comments made through written procedure.

Action required

3. The delegates are invited to:

- COMMENT on the draft and DISCUSS relevance of the findings
- SUGGEST additional literature, if any, to be included in this study to ensure the global knowledge base on the impact study of curriculum redesign

1. Introduction

4. This literature review is part of the Curriculum Analysis for Education2030, which is an element of the Future of Education and Skills: the OECD Education2030 project. The major purpose of the OECD Education2030 project is “to develop a common language and shared space within which countries could both individually and collectively, explore issues around the design of instructional systems” (EDU/EDPC (2016)6, p.2). The Education2030 project aims to build a solid understanding of how the dimensions knowledge, skills, attitudes and values are involved in the design of instructional systems (EDU/EDPC (2016)6, p2).

5. Three key policy issues at stake during curriculum design are identified by the Informal Working Group for the Education 2030 project: 1) Quality of curriculum (including overload); 2) Equity and opportunities to learn; 3) Planning effective implementation and time lag dilemma;

6. Curriculum as a plan for learning (Taba, 1962) is a complex construct, which manifests itself as the intended, implemented, attained curriculum (Goodlad & Associates, 1979; van den Akker, 2003) as well as the evaluated curriculum. The intended curriculum refers to the curriculum intentions as described in policies and curriculum documents. The implemented curriculum concerns the curriculum in action – how teachers interpret and teach the curriculum in practice. The attained curriculum is about the results of the curriculum: the experiences and learning outcomes of students. Finally the evaluated curriculum refers to the effectiveness and efficiency of planning and monitoring of the curriculum at the system level. These different manifestations of a curriculum offer a conceptual framework for the evaluation of a curriculum reform.

7. For describing the quality of a curriculum we adopted the three terms, which are also used in the Education2030 project: coherence, focus and rigor. Coherence is a curriculum characteristic indicating the extent to which curriculum aims and content, as well as textbooks, teaching methods, and assessment are

all aligned and reinforce one another. Curriculum focus addresses the number of topics being taught in a subject domain. To prevent fragmentation of learning a focused curriculum favors learning of a few topics in-depth over shallow learning of many topics of a subject domain. Finally rigor refers to a curriculum that aims at developing conceptual understanding, procedural skills and fluency of application of concepts.

8. The underlying assumption for this review is that to be able to interpret the findings of the studies that are being reviewed it is essential to understand the context of the curriculum reform and in particular how the curriculum is regulated. Curriculum regulation refers to governing education through *directives at input* (e.g. attainment goals, standards) *and output level* (e.g. national exams, standardized tests, inspectorate), leading to limited room for curriculum decision making at the school level. Curriculum deregulation reflects governing education by staying away from control at the input and output level and giving room for curriculum decision making at school level (Kuipers, Nieveen & Berkvens, 2013).

9. The purpose of this literature review is to systematize the knowledge about the impact of curriculum reforms in jurisdictions (national, provincial, state). The following questions guide the review:

1. What kind of curriculum reforms in jurisdictions are being undertaken, and how do these reforms cope with the three key policy issues?

10. The curriculum reforms at stake can differ in terms of focus and scope, implying that both subject reforms as general curriculum reforms will be included in the study.

2. What are the impacts of the intended curriculum reform on the implemented curriculum, attained curriculum, evaluated curriculum are identified by research?

11. The review seeks to identify the outcomes of the curriculum reforms under study, such as the quality of teaching practices (implemented curriculum), student experiences and outcomes (attained curriculum) or equity of outcomes and access for a diverse student population (evaluated curriculum).

3. What are the mechanisms and lessons learned from national curriculum redesign processes (not country studies) (“lessons learnt”)?

12. Finally the review aims to impart insights in the mechanisms and lessons learnt on these the three key policy factors mentioned above: Quality of curriculum content (inc. curriculum overload), Equity and opportunity of learning and Planning effective implementation (incl. time lag). Although the review will incorporate country studies, the aim of this review is not to compare curriculum reforms across countries.

13. The overall aim of the literature review is to contribute to a better understanding how curriculum reform intentions affect the implemented, attained and evaluated curriculum.

2. Methodology

2.1 Search strategy and analysis

14. The search was conducted in three scientific datasets (i.e. Education Resources Information Center (ERIC), Web of Science, and Scopus) and was limited to peer-reviewed publications published between 1990 and (April) 2016 in the English language. The search strategy was based on the combination of three key terms: curriculum reform, state and K-12 (see Appendix 1). This resulted in 470 unique publications. In addition we received 4 publications from countries participating in the OECD Education2030 project, which we added to the initial dataset.

15. To include publications in the final dataset we used the following inclusion criteria:

1. the publication is peer-reviewed.
2. the publication is an original study and based on empirical evidence.
3. the reform presented in the publication is initiated in 1985 or later and
4. the publication is online accessible through the university library or send to the research team (only the input from participating countries).

16. One member of the research team checked the abstracts to determine whether a publication satisfied the inclusion criteria. When the information in the abstract was insufficient the article was screened. In case of doubt, the researcher asked for a second opinion by one other member of the research team. Differences in opinions were discussed until agreement was reached.

17. The final dataset consisted of 37 publications, which were read and summarized in an excel file and a word template. To warrant the reliability of the summaries the terms used in the excel file/ template were defined (see Appendix 2) and examples were provided.

18. The summary describes: background information (author(s), date of publication, title, jurisdiction); purpose and context (incl. curriculum regulation when appropriate) of the study, research question(s); research design; kind of reform (general reform/ subject reform); subject domains; general conclusions and specific conclusions about the three key policy factors: planning effective implementation (incl. time lag), quality of content (incl. curriculum overload) and equity and opportunity to learn. Two members of the research team used the summaries as primary tool for synthesizing the findings from the studies. When necessary they went back to the original publication.

2.2 Overview of the sample

19. A complete overview of the studies in the sample is presented in Appendix 3. The articles included in this review were published between 1995 and 2016. Table 1 presents an overview on how the studies are distributed across this period of time.

Table 1: Number of studies in the dataset distributed across period of time

Period of publication	Nr of studies
<2000	3
2000 - 2005	3
2005 -2010	11
>2010	20

20. Studies from seventeen different jurisdictions were included in the review. China, England, Turkey, Hong Kong and the USA (one study addressing a state policy in Illinois) each provided five studies to the dataset. Cambodia, Canada (Quebec), Israel, Korea, Nepal, Scotland, South Africa, Taiwan, Norway, Germany (Saxony-Anhalt), Thailand and India (Karnatka) are represented with one study.

21. Table 2 provides an overview of the methodology applied in the studies. Most studies in our dataset applied quantitative methods (17), followed by mixed methods (11). They varied a lot in size and scope. Amongst the studies in the dataset is a (quasi-) experimental study conducted in one school with one teacher and 35/34 students in respectively the experimental/control group) as well as a large survey study with more than 5000 students and a study with more than 1600 teachers. Specific information about the sample sizes of each study is included in Appendix 3.

Table 2: Number of studies in the dataset per methodology applied

Methodology	Nr of studies
(Quasi-)experiment	3
Quantitative (e.g. survey)	17
Mixed methods	11
Qualitative (e.g. case studies, interviews)	6

3. Results

3.1 Overview of the reforms

22. Sixteen studies in this review investigated a general curriculum reform and 21 studies concerned on subject matter reform. Relatively many of the latter studies focused on reform in science education (10). See Appendix 3 for the subjects addressed in the other studies.

23. The number of studies per type of reform and per key policy factor is presented in Table 3. Seventeen studies dealt with aspects of quality of content, only two studies referred to curriculum overload as experienced by teachers. Nine studies in the dataset reported findings related to equity and opportunity to learn. Table 4 presents the number of studies per topic.

Table 3: Number of studies per type of reform

	General curriculum reform	Subject specific reform
Quality of content	6	11
Equity and opportunity to learn	5	4
Planning effective implementation	13	14

Table 4: Number of studies per topic addressed

	Number of studies
Quality of content:	
- Alignment of curriculum content/goals with teachers' practice	7
- Alignment between the curriculum reform and student learning dispositions	2
- Effects of generic curriculum reforms on student outcomes	3
- Effects of subject reforms on student outcomes	5
Equity and opportunity to learn	
- Effects of curriculum reforms on disadvantaged students	5
- Effects of curriculum reforms on girls	2
- Effects of curriculum reforms on students in developing countries	3
Planning effective implementation	
- Teacher involvement and collaboration	14
- School leadership involvement	7
- School-based conditions	5
- Curriculum ownership	6
- Implementation support	17
- Social and cultural pressures	17

24. Planning effective implementation was addressed in 27 studies of our dataset. Five of them also discuss issues related to time lag. This implies that most studies addressed more than one key policy factor.

3.2 Quality of curriculum (including overload)

25. The curriculum is a major instrument for governments and schools to improve the quality of education. The findings of this review concerning factors that affect the quality of content will be presented in this section. The studies presented in this section describe generic and subject reforms that align with

approaches to learning, in which goals and content aim at deeper understanding, a focus on developing cognitive skills, connecting learning to real world settings and student active involvement in their learning. Several studies report about (lack of) curriculum coherence¹, in particular related to curriculum intentions and teachers' experiences and practices with the curriculum. Other studies report about the effects of curriculum reforms on student outcomes. The results will be presented around four themes: 1. alignment between curriculum content/goals and teachers' practice, 2. alignment between the curriculum reform and student learning dispositions, 3. effects of generic curriculum reforms on student outcomes and 4. effects of subject curriculum reforms on student outcomes.

Alignment of curriculum content/ goals with teachers' practice

26. Seven studies investigated the (lack of) alignment between the content and goals of the curriculum reform and teachers' instructional practices.

27. In a replication study Hacker and Rowe (1997) (ID472²) compared teaching and learning processes in science classrooms that implemented the National Curriculum in England with teaching and learning processes in science classrooms in the "Nuffield" era of the 1970s. Nuffield science curricula were inquiry-based aiming at the development of higher order cognitive skills. These characteristics are also considered important in the National Curriculum as teaching experimental and investigative skills are mandated. Classroom practices were observed and teachers were interviewed about the differences found in science teachers' instructional practices. The findings showed significant more emphasis on facts and principles instead of higher order cognitive thinking compared to science teaching during 'Nuffield' era as well as less experimentation. The teaching style was mostly focusing on knowledge transfer instead of problem solving or inquiry learning.

28. Teachers gave as an explanation for these findings curriculum overload: they had to cover too much curriculum content in the National Curriculum. The findings from the study of King (2001) (ID588) also suggest a lack of coherence between the intentions of the curriculum, teachers' own perceptions of their teaching and the reality. King (2001) studied teachers' perceptions of the effectiveness of teaching earth science ten years after the implementation of the National Curriculum in England and Wales. For most teachers earth science was a new curriculum topic introduced with the implementation of the National Curriculum. The findings showed a relatively low amount of practical work and investigational content, despite the requirements of the National Curriculum. Teachers themselves perceive their knowledge of earth science and their teaching as moderate. Similarly they see their students' interest and achievement as moderate, but national evaluation studies show that student achievement is poor. To prevent fragmentation of the curriculum King proposes to integrate subject domains, which may lead to more focus of the curriculum.

29. Akar (2014) (ID330) studied the implementation of the new secondary school biology curriculum in Turkey by collecting data about teachers' perceptions and experiences. The curriculum promotes an emphasis on science process skills, relating science to real world setting and active learning. Findings showed that teachers experienced the curriculum as too overloaded, objectives too detailed and content disorganized. In addition they noticed a mismatch with higher education entrance exams (*lack of coherence*).

30. Also Sahin (2010) (ID400) studied the curriculum reform in Turkey, the elementary mathematics curriculum reform in particular. The curriculum reform in Turkey was based on a constructivist theory of education. For elementary mathematics this had implications for curriculum goals (e.g focus on

¹ See the definition of coherence as provided under point 7

² ID<nr> refers to the number of the publication in the datadase, this will be deleted in the final version of the report

mathematical understanding), the content (e.g attention for problem solving, communication, affective development, psychomotor development, connections, and abstract reasoning), the teaching and learning processes (e.g. active involvement of students; teachers as coach monitoring progress) and student achievement (e.g performance tests and portfolio assessments). This study does not provide information about teachers' practice as such, but describes the perceptions of teachers who are actually implementing the mathematics curriculum. Teachers were positive about the all aspects of the reform. Despite these positive perceptions of teachers of the reform, Sahin notices a lack of alignment between the new curriculum and the student entrance exams for secondary and higher education (see also Akar, (2014) and and Nohel (2015), who are also critical about the lack of alignment of the curriculum reform with secondary education and higher education school entrance exams).

31. An example of alignment between intentions of the reform and teachers' beliefs and practice is found in the study of Turner (2006) (ID178) in the domain of English as a Second Language (ESL). Turner (2006) investigated the effects of a provincial curriculum reform in Quebec on ESL teaching. The provincial reform focused on constructivist teaching and learning and was competence-based. For ESL this implied more focus on speaking ability. New requirements for the assessment of speaking ability aimed to encourage teachers to practicing speaking English as well as using English during lessons. Teachers were surveyed to investigate how teachers are affected by the innovation with respect to what and how they teach. Results showed that teachers integrated speaking ability in the curriculum according to the intentions of the reform and that they were knowledgeable about the backgrounds of the reform. The teachers experienced that the exam requirements for speaking ability was aligned with the reform.

32. Sargent (2009) (ID561) studied the alignment of the curriculum reform of 2005 in China with social interactions in the classroom. Teachers were interviewed and their classroom practices observed. In addition students were surveyed about their nature of participation in class and the classroom atmosphere they experienced. Findings showed a positive relationship between the degree of implementation of the new curriculum by the teacher and student active participation in the classroom as well as with a positive classroom atmosphere in which students are praised.

33. McCaffrey et al. (2001) (ID586) studied not only the alignment between curriculum characteristics and teachers' instructional practices, but also included effects on student achievement. Their study took place in the context of high school mathematics curricula in the US and concerns a curriculum reform effort aimed at mathematics that emphasizes problem solving, communication, reasoning and mathematical connections. McCaffrey et al. compared the impact of integrated math versus the traditional sequence of math courses³. These curricula differed with respect to curriculum organization and recommended instructional practices. In the integrated math courses teachers were offered textbooks and materials with collaborative problem solving activities for each lesson. This was not the case for the traditional math courses. The researchers found a positive relationship between teachers' reform based instructional practices - reflecting the intended reform - and student achievement for the integrated math courses. No such relationship was found for the traditional math courses. In addition no relationship was found for any of the courses between teachers' traditional instructional practices and student achievement.

Alignment between the curriculum reform and student learning dispositions

34. Two studies investigated the (lack of) alignment between the curriculum and student attitudes. Tam (2009) (ID404) studied primary school students' attitudes toward homework in Hong Kong from the perspective that homework assignments should be aligned with the aims of the curriculum, i.e. developing a culture of learning to learn and students that enjoy learning. The findings of the study showed that Hong

³ Integrated math: Interactive Mathematics Program (IMP) and College Preparatory Mathematics (CPM) (emphasizing conceptual understanding by open-ended situations and problem-based; traditional sequence of math: algebra I-geometry-II/trigonometry-precalculus course. See also McCaffrey et al. (2001)

Kong primary school students spend a lot of time on their homework and that the amount of time increases as students advance grades. In general students see the intrinsic value of homework, in particular for developing planning and self-regulation skills, suggesting alignment of student attitudes towards homework and curriculum intentions. However, younger students who spend a lot of time in completing their homework were less interested in homework and also less academic and self-regulated efficacy. The author argues that homework needs to be attuned to students' age (maximum 2 hours for upper primary school students). Teachers need to coordinate homework assignments across subjects. The author argued that the design of homework assignments need to be carefully aligned with the aims of the curriculum, that is developing learning to learn skills and enjoyment of learning.

35. Akar (2014), when investigating the implementation of a secondary school biology curriculum through a survey among biology teachers, found that lack of alignment between the curriculum intentions and students' dispositions towards the curriculum (tendency to rote learning, disinterest in the subject and lack of active participation) as perceived by the teachers, hindered the implementation of the reform.

Effects of generic curriculum reforms on student outcomes

36. Three studies in our dataset investigated effects of a general curriculum reform in elementary education on student outcomes.

37. Raj, Sen, Annigeri, Kulkarni and Revankar (2015) (ID506) evaluated in a large scale survey study the effects of a child-centered curriculum reform (Nali Kali – joyful learning) on student learning outcomes in primary government schools in one of the states in India. The curriculum aimed at fostering creativity and experimentation in students' learning processes as well as changing the traditional hierarchy between students and teachers. Students move through the program at their own pace based on mastery of competencies in mother tongue and mathematics. Formative assessment strategies, in which the child is actively involved, are used to determine to what extent student master competencies. Formative assessment strategies, in which the child is actively involved, are used to determine to what extent student master competencies. Teachers are supported in their teaching by curriculum materials and at least one teacher in schools adopting Nali Kali is trained. Results show that the program has positive affects on student performance in mother tongue and mathematics.

38. Nonoyama-Taruma and Bredenberg (2009) (ID411) report about the effect of a school readiness program (8 weeks, 4 hours per day) in Cambodia integrated in the grade 1 primary school curriculum. The school readiness program was embedded in the grade 1 primary school curriculum to affect all children. The school readiness program emphasized the development of basic language skills (speaking listening and reading) and focused on the development of fine and gross motor skills through song, role play, drawing and games.

39. Lam, So and Ng (ID2015) (291) studied the effects of the 2001 curriculum reform of secondary education in Hong Kong. The major purpose of this reform was to ensure "necessary exposure of students for a broad and balanced curriculum and to nurture whole-person development" (p.313). An important part of the curriculum was to promote students' generic competencies, and in this way to prepare students for living in a world that is globalized and changing fast. In the 3-year New Senior Secondary (NSS) students take four compulsory subjects (Mathematics, English Language, Chinese Language and Liberal Studies) and 2 or 3 electives including Other Learning Experiences (OLE). Liberal Studies is new and has as aim "to enhance students' awareness of contemporary social and cultural issues through encouraging the understanding of the role of an individual in society and engaging in self-directed learning and critical thinking" (p. 225). OLE takes 405 hours of extra-curricular activities and aims to develop students' generic skills with a focus on self-development. Students complete a Student Learning Profile. In this study three generic competencies were measured: social and national responsibility, cultural appreciation and global

outlook. Tertiary education students from three consecutive years (2010, 2011, 2012) were asked to complete a self-assessment inventory. Students from the 2010, 2011 and part of the 2012 cohort were taught according to the former secondary school curriculum. Another part of the 2012 cohort was educated according to the new curriculum. Results showed a positive development in all three generic competencies over the years, with students who were most recently graduated from secondary education (2012 cohort) having the highest score on all three competencies. No statistical differences were found between the two groups of students in the 2012 cohort. The authors argue that the co-existence of the former and new curriculum in secondary schools possibly also affected those who were educated in the old curriculum, because teachers had to teach both cohorts at the same time.

Effects of subject curriculum reforms on student outcomes

40. Five studies in our dataset examined the effects of subject curriculum reforms on student outcomes often related to science and math curriculum reform efforts. The curriculum reforms discussed here aim to bring rigor in the curriculum, implying that the curriculum reforms aims to develop conceptual understanding instead of the learning of facts, often through pedagogical approaches that foster active learning.

41. In a large study with 48 elementary schools, Hand, Therrien and Shelly (2013) (ID3) studied the effects on student learning outcomes of an inquiry-based science curriculum, called the Science Writing Heuristics (SWH) Approach, in the US. The SWH curriculum aligns with the Next Generation Science Standards (1999). Hand et al. (2013) compared elementary schools that used the SWH curriculum with schools that used a conventional science curriculum. The SWH curriculum emphasizes argumentation over the memory of facts. The focus of the curriculum is on big ideas and alignment of teaching and learning. In the curriculum language is considered important for learning science. Central in the approach is a framework that helps students' to build their argumentation and reasoning when they discuss data. Findings show that student test scores in mathematics and reading on a standardized test improved. The SWH students started with lower scores on the pre-test compared to control group students, but this difference in scores disappeared after four semesters. This was not the case for the science scores, probably because the science test focused on facts and content and not on inquiry, implying that the science test was not aligned with the goals and learning activities of the SHW curriculum, which is an example of lack of coherence.

42. Carroll (1997) (ID233) analyzed the effect of an innovative elementary math curriculum in Illinois. The curriculum emphasized exploring mathematics in real life settings and sharing solutions of mathematical problems in the classroom. The use of mathematical tools and manipulatives, such as calculators and rulers, in Kindergarten and beyond was encouraged. This large study showed a positive impact of the curriculum on student scores on a standardized test, compared to two benchmark measures: respectively state and county data. Our dataset contains similar, but much smaller studies about middle school science in the US (Eick, Dias & Smith, 2009) (ID133) and high school science in Taiwan (Shein & Tsai, 2015) (ID9). The study of Eick et al (2013) is about a middle school science curriculum intending to develop deep conceptual understanding of physical science concepts (e.g. about Mechanical waves and energy transfer). Students make their prior ideas explicit, then explore concepts by inquiry, present and negotiate about their findings and formulate what they learned. The effects of the curriculum on student learning outcomes were investigated. Using a pre-test post-test design significant gains in student understanding of the specific concepts taught were found. In a quasi-experimental design Shein and Tsai (2015) investigated the effect of a high school science curriculum collaboratively designed by science teachers and scientists. The curriculum on environmental science aimed to integrate advance science and technology in the high school curriculum. A medium effect on students' scientific competency and a large effect on students' interest in science was found. Science curriculum reform in Thailand aimed to promote deep understanding of science concepts and theories, as well as the nature of science and the process of

science research. In the frame of this reform, Dahsah and Coll (2008) (ID153) investigated the conceptions secondary school students' hold about stoichiometry (chemistry) and related concepts. Findings showed that most students did not show a sound understanding of many of the concepts related to stoichiometry. In order to improve this situation the authors propose to better align the reform intention with curriculum documents by specifying conceptual understanding and numerical problem-solving ability in learning objectives, and to align assessment practices with learning objectives. *Lack of coherence* between curriculum reform goals with curriculum documents and assessment practices show that the ambitions of curriculum reforms may not be realized in practice.

3.3 Equity and opportunities to learn

43. A major concern in many curriculum reforms is to provide opportunities to learn for all students. Nine studies in our dataset address this issue. The results will be presented around four themes: 1. effects of curriculum reforms on disadvantaged students, 2. effects of curriculum reforms on girls, and 3. effects of curriculum reforms on students in developing nations. We did not find studies focusing on differential effects of curriculum reforms on boys.

Effects of curriculum reforms on disadvantaged students

44. Five studies in the dataset addressed the effects of curriculum reforms on students from low socio-economic backgrounds or disadvantaged schools. Feniger (2015) (ID12) studied the effect of the expansion of academic studies for students traditionally send to vocational education in Israel. An important reason for this reform was to offer students in vocational education, who mostly come from socio-economically underprivileged immigrant backgrounds, better opportunities for further studies or the working life by preparing them for the general secondary matriculation exam. Feniger (2015) showed that schools that implemented the reform became more heterogeneous in population compared to schools that kept the traditional vocational tracks in place. Students from the lower socio economic backgrounds in schools that implemented the reform benefitted from it because they had the opportunity to prepare themselves for the general secondary matriculation exam, which was not possible in the traditional vocational schools.

45. Hand et al. (2013)(ID 3) in elementary school science and Carroll (1997) (ID233) in elementary school mathematics (Carroll, 1997) (233), both in the US, found a positive effect of their respective curriculum reform on disadvantaged students. Hand et al (2013) (3) applied a randomized experimental design to compare schools that applied the Science Writing Heuristic (SWH) approach (learning science through argumentation) with schools that taught science in a more conventional way (memorizing facts) (see also Quality of Content). The findings showed that the math and reading scores of students in disadvantaged schools (students with low SES background) using the SWH approach improved to the level of students from advantaged schools (students with middle/high SES background), being taught science in the conventional way. Carroll (1997) (ID233) analyzed test results of schools teaching an innovative elementary math curriculum (see also Quality of Content). This study showed that the mathematics scores of schools with a high proportion of low-income students were above the mean state scores.

46. Clotfelder, Ladd and Vigdor (2014) (ID1) studied the effect the differential effects of *acceleration of learning* using the case of the Algebra in the US. A number of states in the US promoted the early introduction to Algebra in middle schools based on the results of correlational studies, which suggested a positive correlation between the introduction of Algebra⁴ already in middle school instead of high school on later-life outcomes. In a quasi-experimental design Clotfelder et al. (2014) demonstrated

⁴ No further information about the Algebra curriculum is provided in the study. The main aim of this study was to criticize policy decisions based on correlational studies instead of ordinary least squares regression analysis.

that the assumed causal relation could not be confirmed. Moreover, the authors found that the early offering of Algebra had negative effects on low performing students, but were beneficial for high performing students. The authors argue that a single curriculum reform such as offering Algebra at an earlier grade level, without coherent reforms in related subjects at the same time do not yield the anticipated outcomes.

47. Homer, Ryder & Donnelly (2013) (ID56) studied *participation patterns* in different science courses offered in England. In Key stage 4 (age 14-16) students can enroll in integrated science, science courses with a focus on work-related learning, such as healthcare and forensic science. (Applied Science) as well as - since 2008 -science courses offered as three separate subjects, biology, chemistry and physics ('Triple Award' science). The first approach emphasizes scientific literacy while the latter aims at preparing students for science programs in further education. The findings show the enrolment in 'Triple Award' science of students from low SES backgrounds is and stays low, also when accounted for prior attainment. The author's conclude that prior attainment is an important reason for this finding.

Effects of curriculum reforms on girls

48. Two studies addressed effects curriculum reforms on girls. The study of Homer et al. (2013), described above, found a positive effect of 'Triple Award' science courses on the enrolment of girls. The authors conclude that this effect may be explained by societal pressure and not as a result of the curriculum reform itself.

49. Meyer and Thomsen (2016) (ID279) studied the effect of shortening the secondary school curriculum on students' decisions for further studies. The reason for this curriculum reform was the earlier participation at the labor market university of graduates. In several states in Germany secondary education preparing for university was shortened with one year of schooling. However, the content of the curriculum stayed the same. The findings show that female students are more affected by this reform than male students. Female students with 12 years of schooling did not enroll in university immediately but started in vocational education first. In addition they were less likely to enroll in STEM programs of study. To explain these findings the authors argue that female students perceive their chances on success in further studies lower than male students. In addition they react different to increased pressure, which is a result of the intense curriculum.

Effects of curriculum reforms on students in developing nations

50. Three studies in our dataset address the effects of curriculum reform on students in developing nations.

51. To reduce the high repetition of grades and to improve access of children to primary schools the government of Cambodia developed a school readiness program Cambodia (Nonoyama-Taruma & Bredenberg, 2009, see also Quality of Content). Compared with expanding pre-school education (for instance in a summer school) a school readiness program incorporated in the primary school curriculum (which is compulsory for all students) was seen as a realistic possibility to affect all children entering formal education instead of a few. For this reason the school readiness program was embedded in the first two months of grade one. The findings of a pilot study showed positive effects of the program on school readiness and achievement in the formal curriculum.

52. Raj et al, (2015) (ID506) evaluated the effects of a child-centered curriculum, Nali Kali, in a rural state (Karnataka) in India (see also Quality of Content). Schools teaching the curriculum were well prepared. The positive effects of the curriculum on the learning performance in math and mother tongue of

children taught by this curriculum are particularly relevant because most children in the program came from rural areas and had socially disadvantaged backgrounds.

53. Khanya & Williams (2004) (ID445) describe the effect of a generic curriculum reform initiated by the government in Nepal after four years of implementation. The reform aimed at improving the quality of primary education, increasing equitable access, strengthen school management and improve pre- and in-service teacher education. As a result a new curriculum for primary education was developed, textbooks were developed and professional development for teachers was offered. Despite the positive findings of evaluation reports on the success of the reform, Khanya and Williams showed no effects of the reform on student achievement in language arts and mathematics. Only student achievement in social studies was substantially higher. The authors found large differences between regions, with scores in Kathmandu being substantially higher than in other, more rural areas. Students' background and school resources (see also Planning Effective Implementation) accounted for the low performance, suggesting that the reform insufficiently had addressed the needs of students and schools.

3.4 Planning effective implementation and time lag dilemma

54. Curriculum implementation is typically perceived as a complicated endeavour. In this section the findings of the literature review concerning the topic of effective curriculum implementation will be presented. Before doing so, some findings concerning the issue of time lag will be covered. This issue was not discussed in any of the articles the way it has been defined by the OECD working group, i.e. the curriculum renewal becomes outdated before full implementation has been in place because of the speed of changes in society.

55. Some authors did speak about the timing of their implementation studies, however this was done from the perspective that curriculum change itself needs sufficient time before impact can be measured. For instance, Lam, So and Ng (2015) (ID291) report that "curriculum reform requires constant feedback and review to enhance the effectiveness of the teaching and learning by all parties. The educational reform in Hong Kong has been implemented for over ten years, and it is the right time reviewing its progress". The same holds true for Raj et al. (2015) (ID506): "After the lapse of few years it is now opportune time to know the impact that the programme has made on various stake holders and more importantly on the student community." And according to King (2001) (ID588): "Science teachers have now been teaching the earth science component of the NCS for up to 10 years. Initially, the NCS was implemented progressively in secondary schools; teaching began with 11-year-old pupils in 1989/1990 and was not until 1993/1994 that it reached all pupils up to the age of 16." In some cases, the timing of the study was used as an explanation of not (yet) finding substantial changes. For instance, Khaniya and Williams (2004) (ID445) point out that "it was too soon in the reform for results to manifest themselves in learning gains. This explanation should be given some credence. Projects require quite substantial time just to get underway. Presumably, their effects take longer to manifest."

56. When turning to the 27 studies in the database that addressed issues related to effective curriculum implementation, it is important to keep in mind the complexities of curriculum implementation and that sufficient time and patience is required to let the change get to its full potential. In order to find some patterns in the issues that were raised by the authors, the issues were grouped around the following six (interrelated) themes: 1. teacher involvement and collaboration; 2. school leadership involvement; 3. school-based conditions; 4. curriculum ownership; 5. implementation support; and 6. social and cultural pressure.

Teacher involvement and collaboration

57. In the database, 14 studies highlighted the importance of teacher involvement in the curriculum change process. Kirkgoz (2008) (ID 148) underlines what most authors (implicitly) took as a starting point for their implementation studies, that is: teachers have a crucial role in the successful development of the innovation within the school system. If teachers do not adapt their teaching, students will not be taught differently. Kim and Bolger (2016) (ID 281) state that "teachers are the ultimate point at which curricular reform must be implemented. If they lack knowledge, confidence, and curricular supports to implement change, that change is unlikely to occur as intended." Vulliamy and Webb (1995) (ID 228) emphasize the importance of teachers by stating that "whether or not an individual pupil receives an appropriately broad and in-depth curriculum depends more on the characteristics of individual teachers than on the size of school in which they work".

58. Lee, Yin, Zhang and Jin (2011) (ID 91) found, based on a large scale survey under teachers in mainland China, three significant predictors regarding the impact of the independent variables on teachers' perceived outcomes of curriculum reform: professional growth, support in schools, and decision making. Being involved in the decision-making process increases the knowledge of the change at hand. MacLean, Mulholland, Gray and Horrell (2013) (ID 14) explain that in their study teacher's insufficient knowledge of reasons for change may have contributed to a lack of motivation to implement new initiatives effectively. The intended change will be limited if teachers do not fully support and understand the details of the new curriculum framework.

59. Ramberg (2014) (ID 6) found that teacher collaboration in designing school-based curricula plays (amongst others) a crucial role in teachers' efforts to bring about change in practice and also Cheung and Wong (2012) (ID 78) put forward that consensus building and collaborative effort of teachers are key factors for making the curriculum reform a success. Tong (2010) (ID393) explains, based on schools' responses to curriculum change in Hong Kong, that curriculum development should be considered as a learning process in which social construction of knowledge is a key feature. "Effective change entails teachers experimenting and sharing experiences to clarify and understand the assumptions underlying the curriculum when selecting and adapting the curriculum before they are able to decide whether such assumptions are valid for their school". Akar (2014) (ID330) points out that in their study the process of curriculum development was rushed and had not been discussed in a wider context at sufficient length, leading to the conclusion that the actual problems of curriculum delivery call for bringing out teachers' perspectives and experiences of constraints (teachers not involved in curriculum development, no professional development opportunities for teachers, lack of physical facilities of the schools and the negative effect of higher education entrance exams) affecting the enactment of the curriculum.

60. Lee, Yin, Zhang and Jin (2011) (ID 91) provide one caution by pointing out that under the curriculum reform in China, teachers already are busy and more participation in school-wide decision making may reduce the time and efforts spent on curriculum and instruction for the benefit of student learning. Vulliamy and Webb (1995) (ID248) add to this, based on a study in England and Wales, the importance that teachers who take up the leadership role of subject co-ordinator also need to remain teaching. Although these subject co-ordinators, who take the lead in subject related curriculum reforms, raised the overall confidence of teachers throughout their school, a lack of non-contact time has generally prohibited their being able to make a noticeable impact on the classroom practice of their colleagues.

School leadership involvement

61. Of all studies included in this review, seven elaborate on the importance of school leadership involvement. Based on the findings, Ramberg (2014) (ID6) emphasizes the important work of school leadership in promoting favourable school conditions for teachers' change of practices. This study also

illuminates the need for schools to continuously consider how organizational conditions may serve to support and develop issues of teacher change and curriculum implementation more successfully. Next to organizational conditions, Cheung and Wong (2012) (ID 78) put forward that school heads and curriculum leaders in Hong Kong need to give teachers clear implementation guidelines for the reforms in order to improve teachers' understanding of the reform. Tong (2010) (ID393) adds that poor management of the change by school leaders was one of the reasons for the dismal results of curriculum change in Hong Kong. However Tong (2010) showed that lessons were learned from these experiences. In his study Tong mentions three distinct roles of leadership of senior management to cope with change: With respect to curriculum and instructional leadership, most principals encouraged teachers to acquire essential curriculum practice and skills by attending professional seminars in other educational organizations. With regard to supervisory leadership, some principals promoted collaborative relationships among teachers so that they worked co-operatively and produced useful outcomes.

62. Yin, Lee and Wang (2014) (ID 24) shed some light on conflicts that change leaders encounter in the implementation process in China. The results show that leading the curriculum reform process in schools is dramatically inhibited by the existing cultural values in China, such as a compliance culture, examination culture and traditional educational values (more on this under social and cultural pressure).

School-based conditions

63. Five articles elaborated more explicitly on school-based conditions that are favourable for curriculum implementation in schools on top of the crucial role of school leadership and teacher collaboration as were highlighted in the previous sections. MacLean, Mulholland, Gray and Horrell (2013) (ID 14) found that teachers who appeared to enact the policy rationale were working in schools with a supportive culture and infrastructure. "[They] tended to operate in an environment that placed value on teacher agency within a cultural setting that embraced interdisciplinary learning (i.e. collaboration between teachers of different subject matter domains). The social structure of these schools provided support, guidance and feedback on teachers' efforts to engage with and enact new curriculum initiatives. Although this process was time-consuming and involved an increase in workload, teachers felt part of a team developing curricula in an atmosphere of collaboration, where conversation and professional activity helped them to 'form' policy" (p.92-93). Tong (2010) (ID393) points at the importance of creating a collaborative working environment in schools, in which teachers have opportunities to discuss curriculum implementation and develop themselves further by interacting with colleagues. In these environments principals also have a role to play, for instance by adopting a reflective consultative approach in participating in some of the working groups and providing teachers advice and support when necessary.

64. On the opposite, a lack of shared planning or instruction can pose a challenge for sustainability of integrated curricula (Kim & Bolger, 2016) (ID281). On top of these cultural and structural affordances, the conditions at the school level also cover the basic conditions for teaching and learning. For instance, Nonoyama-Tarumi and Bredenberg (2009) (ID 411) point to the importance of the physical upgrading of classrooms in Cambodia to foster the change towards providing engaging instruction with numerous activities involving songs, role plays, drawing and games. In order to facilitate these changes in classroom practice, physical classroom environments also needed to undergo a certain amount of upgrading. This usually included the provision of stationery and raw materials for the production of teaching aids as well as decorations to make classroom environments more interesting. A similar point was made by Khaniya and Williams (2004) (ID 445), who reported on the insufficiency of resources at school level, for instance funds to purchase additional instructional materials and while 95% of the schools had benches and desks, there were not enough seats for all students. This understandably hindered the implementation process in Nepal.

Curriculum ownership

65. Six articles discussed the issue of the curriculum ownership as an important element to consider in effective curriculum implementation processes. For instance, Khaniya and Williams (2004) (ID445) report based on their study in Nepal that "too heavy a reliance on ready-made external packages of reforms can lead to the bypassing of local institutions that can "own" and implement complex reforms of this kind". MacLean, Mulholland, Gray and Horrell (2013) (ID 14), refer to the importance that if a country incorporates contextualised policy processes into curriculum design and invite teachers to become actively involved in the design of curriculum innovation, this also implies clear communication of the rationale of the renewal. Without such a clearly communicated vision there is a danger that the change will be watered down.

66. The findings of Bell and Donnelly (2009) (ID 408) underline this. They found as a very important element of this 'co-production' that teachers adapted the meaning of change to their existing understandings of good (in this case science) teaching. They studied the introduction and uptake of Applied Science in the National Curriculum of England and Wales. To address concerns that the National Curriculum in England was too much based on academic subjects, so called vocational subjects were introduced in 2000 (besides Applied Science also for instance: Applied art and design, Applied business, Engineering, Manufacturing). However Applied Science did not add a vocational focus to the curriculum, as was the original intention of the reform, because it was enacted as a general science course and became a means for schools and teachers to target lower-attainment students for this course (see also the study of Homer et al. (2013), described earlier, which also studied the implications of the introduction of Applied Science).

67. Nevertheless, the study of Ramberg (2014) (ID 6) seems to underscore the importance of supporting teachers as agents of change in efforts to improve educational practices. School-based curricula work showed a direct influence on teachers' general orientations towards the reform and the perceptions teachers have about the degree of implementation of the reform in their teaching. Moreover, the study of Tong (2010) (ID393) also shows that schools and teachers are capable of drawing lessons from their previous experiences of curriculum reform, for instance with respect to management support (9se also School leadership support).

Implementation support

68. In 17 articles the support for curriculum change has been elaborated. Especially in studies carried out in countries that have substantial input and output regulation, findings show a call for alignment of the changing standards, the national textbooks and teacher capacity building (e.g Kim & Bolger, 2016) (ID 281). The study of Sahin (2010) (ID400) in Turkey, showed that samples in the 2005–2006 survey were less positive about the reform of the elementary mathematics curriculum compared to the samples in the 2004–2005 survey. According to Sahin, the reason for this may be that the Ministry provided more in-service teacher training and supplementary materials and tools in the 2004–2005 school year when the new curriculums were being piloted. However, the necessary amount of freedom and guidance is seen as a balancing act in several contributions. On the one hand clear-cut prescriptions for how to teach are unlikely to be effective (McCaffrey, Hamilton, Stecher, Klein, Bugliari & Robyn, 2001) (ID586). On the other hand rather vague by level descriptions were also not seen as providing clear pathways for local curriculum development (cf. Hacker & Rowe, 1997) (ID 472).

69. The need for providing professional development for teachers is emphasized by many authors. Cheung and Wong (2012) (ID78) studied the curriculum reform in Hong Kong during its first stage of implementation (2001-2006). One of the aims of this reform was to better handle learner diversity in the curriculum. According to Cheung and Wong (2012) "teachers should be provided with sufficient

professional development opportunities in various areas, [in their case] especially in critical thinking skills training, learner diversity, and inclusive education" (p. 51). Kirkgoz (2008) (ID152) states that, to ensure full implementation, capacity building needs to be continuous and developmental by nature, particularly during the first critical years of curriculum reform.

70. Kirkgoz (2008) (ID152) adds, based on the findings, that teacher educators need to receive "a 'trainer training programme' to increase their awareness of the implementation of the innovation in practice for the practising teachers, and to maximize the chances of curriculum objectives being implemented in classrooms. As a crucial component of such a programme, trainers need to be encouraged to take teachers' existing beliefs and classroom practices into account in introducing new ideas to help facilitate the professional and cultural adjustments that curriculum change requires of the teachers." This latter point has also been made by Sanders and Ngxola (2009) (ID 405).

71. Usually, curriculum implementation also needs some sort of financial support. Findings of Hacker and Rowe (1997) (ID 472) show that many teachers in England and Wales suggested that financial constraints (e.g. needed for setting up a laboratory and laboratory equipment) mitigated against practical work. Cheung and Wong (2012) point to school principals' and teachers' perceptions about the importance of smaller class size to help to implement the inclusive education policy and conclude that this needs further study. These constraints can be severe, going beyond the curriculum change at stake, for instance resembled in the study of Khaniya and Williams (2004) (ID445) "the poverty and competing claims of daily life on the attention of children and their families may mean that school inputs have relatively little effect on learning." In this Nepalese study also logistical issues developed—transportation of materials, communication with schools for direction and collection of information, poor quality of postal service, and so forth.

72. Moreover, the need for sufficient interaction between the many players in the curriculum arena has also been covered in several articles. For instance, Tong (2010) (ID393) emphasizes the importance of strong leadership and management by policy makers, schools leaders and teachers in Hong Kong. Ramberg (2014) (ID6) concludes with respect to the interplay that "in the case of work with school-based curricula, implementation quality depends on a series of conditions, including the interactions between education authorities, school owners, and school leadership and collaboration between teachers" (p. 48).

Social and cultural pressures

73. The final issue, raised in 17 articles, is concerned with the social and cultural pressures Findings of Wong and Cheung (2015) (ID10) about the curriculum reform in Hong Kong seem to be positive in this respect: "School principals and teachers indicated that they found the initiatives very useful in clarifying the reform items and serving their needs" (p.842). These initiatives from the government, such as reengineering work processes in schools and reduction of unnecessary administrative tasks, flexible time tables, the creation of space for students to learn and for teachers to focus, aimed to support the implementation of the reform. School principals and teachers said to be "well supported by the efforts and strategies made by the government in terms of financial support to schools, central curriculum guides, provision of principal and teacher training programs, on-site school-based support, partnership programs and other supportive measures. The reform received agreement and support from most principals, curriculum leaders and teachers of primary and secondary schools." (p.842)

74. However, other authors raise serious issues concerning a mismatch between the curriculum renewal and its circumstances in the larger context. For instance, Somel and Nohl (2015) (ID 5) indicate, if the education system (tacitly) fosters fierce competition this may even lead to negation of the curriculum. They studied curricular practices in five schools implementing the new compulsory primary school curriculum of 2005 in Turkey. The new primary school curriculum was developed in the context of a

highly competitive secondary and tertiary education system. The new primary school curriculum had adopted a constructivist approach to teaching and learning, which conflicted with the centralized entrance examinations for access to secondary education. The findings of the study suggest differential effects on curriculum enactment in rural, low-income urban and middle-income urban schools due to the pressure schools' experience in preparing students for the secondary school entrance exam. While the two urban schools, although in different ways, were affected by the competition in secondary school access this was not the case in the rural schools. In the low-income urban school parents' saw access to quality secondary education as a means to improve the future of their children and therefore wanted their children to prepare for the exam at school. This was not the case in the urban school with middle-income parents', because they were able to pay for private examination preparation. In this school the reform was therefore implemented as intended.

75. Sargent (2011)(ID 83) reports that according to the teachers who participated in the study important barriers to reform implementation were pressure from the examinations, inadequate resources, and large class sizes. Also Akar (2014) (ID330) reports on inconsistencies between the intended curriculum changes with other system components in Turkey, such as a lack of qualified teachers, physical facilities of the schools and negative effect of university entrance exam. Sahan (2010) (ID400) reports that preparing teachers and also parents for the new curricula and teaching approaches seem to be the most important in Turkey. As long as the high stakes entrance examinations remain important for students and parents, it will not be easy for students and parents to accept and adapt to a new curriculum which emphasizes experience and individual differences.

76. MacLean, Mulholland, Gray and Horrell (2013) (ID14) found, based on their survey under PE teachers and individual face-to-face interviews in Scotland, that crucial to the resistance was not the teachers themselves, but rather the social and cultural pressures on their practice that limited their capacity to embrace change. Results of the study of Yin, Lee and Wang (2014) (ID 24) go in the same direction showing that leading the curriculum reform process in China is seriously constrained by the existing cultural values in China, such as compliance culture, examination culture and traditional educational values. They explain that curriculum reforms will only do well when they are consistent with the cultural values embedded in the larger social context. According to these authors, reform processes are by no means a simple 'copy and paste' exercise from innovations that originated in Western countries, but are in need of a subtle fusion and modification according to the local cultural context.

4. Mechanisms and lessons learned

77. This literature review aimed to systematize knowledge about the impact of curriculum reforms on teaching and learning. The curriculum reforms in our dataset comprised generic and subject curriculum reforms. In most studies governments at the national, state or provincial level initiated the curriculum reforms. The subject reforms in the dataset mainly dealt with science and math curriculum reform. Many reforms in our dataset align with constructivist approaches to learning, i.e. goals and content that aim at deeper understanding; developing cognitive skills, connecting learning to real world settings and student active involvement in their learning. In addition to student self-regulation was mentioned in a number of studies, in particular related to the reform in Hong Kong. From the perspective of curriculum reform implementation teacher agency was considered important in a number of studies. Some reforms had a slightly different nature, because they primarily aim to improve the chances for students on school success.,

4.1 Key messages

78. In this study *coherence* was defined as ‘a curriculum characteristic indicating the extent to which curriculum aims and content, as well as textbooks, teaching methods, and assessment are all aligned and reinforce one another’. The importance of coherence as an important characteristic of a quality curriculum is confirmed by a number of studies in this review. Several studies showed effects of alignment as well as lack of alignment between curriculum intentions and teaching practice. For example McCaffrey et al. (2001) found that intended reform reflected in reform-based instructional practices positively affects student outcomes. However such alignment was not always realized. From the teachers’ perspective curriculum overload was seen as a reason for not complying with curriculum intentions. Also teachers’ misconceptions about the required change often resulted in lack of alignment between intentions and practice. In addition alignment between the curriculum and student dispositions towards the curriculum was considered important to realize curriculum intentions. One other form of (lack of) coherence was found, viz. the lack of coherence between different subjects in the curriculum. The study of Clotfelder et al. (2014) showed that the introduction on a new subject (in this study Algebra) can affect the performance of disadvantaged students in a negative way, if this reform is not aligned with the curriculum as a whole.

79. Many of the generic and subject curriculum reforms, the latter in particular in the STEM domain, reflect the importance of coherence, focus and rigor as quality characteristic of a curriculum. In general these reforms resulted in positive effects on student outcomes, except when the reform goals did not match with curriculum materials and assessment practices.

80. The findings of this review showed that rigorous and focused curricula also have a positive impact on students from disadvantaged backgrounds. In addition these students benefit when challenging content is offered within the curriculum they are taking. On the other hand the findings also suggest that disadvantaged students tend to select lower level courses when they have options to choose from. Thus offering courses at different levels does not seem beneficial for them.

81. Societal pressure seem to help girls to select high-level science courses in secondary education, but if they experience the curriculum as intensive they may decide not to continue in this field in higher education.

82. Carefully developed curriculum reforms focusing on a specific problem, which are well supported can result in positive outcomes for students in developing countries. Comprehensive large-scale reforms may contribute to the improvement of education, but not always result in increased student performance.

83. The issues raised in the implementation of curriculum reforms (i.e. teacher involvement and collaboration, school leadership, school-based conditions, curriculum ownership, implementation support and social and cultural pressure) are interrelated. For instance, from the studies we learn that teachers, school leadership but also policy makers need to promote supportive favourable conditions to increase the chances that teachers have time and places to engage with the new initiatives and adapt the meaning of the change to fit their existing understandings.

84. This interplay of components makes clear that curriculum implementation is not a straightforward effort. In order to increase our understanding of what actually happens during the implementation of a curriculum change and to be able to explain the outcomes in the classrooms, a more comprehensive approach is needed.

4.2 Emerging models

85. Finally we argue that the kind of implementation process depends to a large degree on the way curriculum regulation is considered in a country. Nieveen, Sluijsmans and van den Akker (2014) explain this relationship by using the concepts of input and output regulation (as were discussed in the introduction to this review) and by linking these with implementation approaches put forward by Snyder, Bolin and Zumwalt (1992), i.e. the fidelity approach and the enactment approach.

86. At the one extreme, curriculum regulation mirrors a government's intention to prescribe the curriculum at the input level in terms of goals and contents and at the output level in terms of modes of assessments and examinations and surveillance by the inspection and governance. Those prescriptions imply a *fidelity approach* to implementation in which the room for site-specific curricular choices is restricted. Teachers are directed to select and use particular lesson units in specified ways. This approach aims at uniformity, requiring that all schools teach the same topics in similar ways. In its most extreme form, this approach leads to a prescribed and controlled "autocue" or "karaoke" curriculum. The players in the educational domain have a role in directing and standardizing the curriculum implementation in the classroom but usually at great cost to professionalism and motivation of teachers.

87. At the other extreme, curriculum deregulation reflects a government's intention to keep away from prescription and control at the input and output level. Here an *enactment approach* would fit, stimulating school-based curriculum decision-making. Here, the intended curriculum provides ample room for teachers and students to make local curricular decisions, for instance, based on what happens in the classroom or in the local school context. At the heart of this "open field curriculum" approach is trusting schools and teachers and students to make site-specific interpretations of curriculum guidelines. The role of the partners in the educational domain is especially to cater the needs and wishes of the schools and teachers and students.

88. Between both extremes, Nieveen, Sluijsmans and van den Akker (2014) position the *mutual adaptation approach* to curriculum implementation. Here the intended curriculum provides clarity about the basic ideas and directions underlying the curriculum change, and provides details in the form of (several alternative) exemplifications that can help teachers adjust to the change. However, at the same time, this approach leaves room for schools and teachers to make suitable on-site modifications, which is seen as an important issue because of the differing circumstances facing schools and teachers. The development process of this "framework curriculum" is "a two-way street" between developers and users: adjustments of teachers will also feed changes in the intended curriculum in order to improve, for instance, its relevance and practicality.

89. When setting out for curriculum implementation it is important to take into account the extent of the change for classroom practice. What needs to get changed and how far away from the current practice

is this proposed change. Moreover, as studies showed in this review, the implementation process should also take into consideration the way curriculum regulation is perceived in a country or region. Yin, Lee and Wang (2014) add to this that curriculum reforms will only do well when they are consistent with the cultural values embedded in the larger social context. For instance, when the curriculum change is planning on taking a big leap away from the current classroom practice, the curriculum implementation process needs to support this change at all levels of educational policy and practice. Moreover, when a country embraces the notion of school-based curriculum development, then the policy regulations need to get adjusted as well, and support on-site curriculum changes. Studying the impact of curriculum implementation at the classroom and student levels will need to take these potential changes into account as well.

4.3 Implications for future research

90. This review is contributing to better insights in the impact of curriculum reforms, but does not allow for firm conclusions. The studies in the review varied a lot in size and in explanatory power. Both small case studies and large-scale effect studies were involved in the dataset. Very few studies had an experimental design. While the large-scale studies provided insights in effects on student outcomes and teacher perceptions of curriculum reforms, the case studies contributed to a better understanding of underlying mechanisms. Together the studies suggest, which themes are addressed in research on curriculum reform impact. It is important to realize that for some of the themes discussed in the results section only a few studies were found.

91. In the section on Quality of Content effects on student outcomes were attributed to the curriculum reform as a whole, but not to specific characteristics of the reform, which would have provided a more in-depth understanding of the qualities of the reform.

92. It is important to note that in some studies discussed in the section on Planning Effective Implementation the implementation process itself was under scrutiny. However, in most studies, implementation-related issues were raised and discussed at the end of the article in response to the findings. The authors reflected on the findings in relation to the implementation processes, either to acquire some possible explanations for the results of their studies, and/or to learn lessons for future curriculum implementation efforts in their particular regions.

93. We found relatively few studies that discussed curriculum overload. When curriculum overload was discussed it was the overload teachers experienced when enacting a curriculum reform. In the studies in this review curriculum overload was not a concern of policy makers and curriculum developers.

94. A main finding of this review was the lack of studies in the dataset that addressed the problem of time lag, referring to the time lag between the content of current curriculum and the desired content curriculum aligned with the societal changes". Further research is needed in this area.

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APPENDIX 1 SEARCH STRATEGY

Datasets

ERIC	273 results (May 5, 2016)
Web of Science	120 results (May 5, 2016)
Scopus	216 results (May 5, 2016)
Total	609 results
Total, deduplicated	470 results

ERIC

Ovid

#1 curriculum reforms

(curriculum ADJ2 (renewal OR innovat* OR reform* OR change)).ti,ab.

Results: 4.075

#2 State

National curriculum/ OR state standards/ OR (national OR state OR region* OR provinc* OR countr* OR federal*).ti,ab.

Results: 310.405

#3 K12

elementary secondary education/ OR grade 1/ OR grade 2/ OR grade 3/ OR grade 4/ OR grade 5/ OR grade 6/ OR grade 7/ OR grade 8/ OR grade 9/ OR grade 10/ OR grade 11/ OR grade 12/ OR elementary education/ OR elementary schools/ OR primary education/ OR public schools/ OR middle schools/ OR junior high schools/ OR secondary education/ OR secondary schools/ OR high schools/ OR (elementary education OR elementary school* OR primary education OR primary school* OR K-12* OR K12 OR 1st-grade* OR first-grade* OR grade 1 OR grade one OR 2nd-grade* OR second-grade* OR grade 2 OR grade two OR 3rd-grade* OR third-grade* OR grade 3 OR grade three OR 4th-grade* OR fourth-grade* OR grade 4 OR grade four OR 5th-grade* OR fifth-grade* OR grade 5 OR grade five OR 6th-grade* OR sixth-grade* OR grade 6 OR grade six OR intermediate general OR secondary education OR secondary school* OR 7th-grade* OR seventh-grade* OR grade 7 OR grade seven OR 8th-grade* OR eight-grade* OR grade 8 OR grade eight OR 9th-grade* OR ninth-grade* OR grade 9 OR grade nine OR 10th-grade* OR tenth-grade* OR grade 10 OR grade ten OR 11th-grade* OR eleventh-grade* OR grade 11 OR grade eleven OR 12th-grade* OR twelfth-grade* OR grade 12 OR grade twelve OR junior high* OR highschool* OR preuniversity OR pre-university).ti,ab.

Results: 562.137

1 AND 2 AND 3 857 results

Limit to peer review 309 results

Limit to 1990-.. 273 results

WEB of SCIENCE

#1 curriculum reforms

TS=(“curriculum” NEAR/1 (“renewal” OR “innovat*” OR “reform*” OR “change”))

Results: 2.107

#2 State

TS=("national" OR "state" OR "region*" OR "provinc*" OR "countr*" OR "federal*")

Results: 4.789.538

#3 K12

TS=("elementary education" OR "elementary school*" OR "primary education" OR "primary school*" OR "K-12*" OR "K12" OR "1st-grade*" OR "first-grade*" OR "grade 1" OR "grade one" OR "2nd-grade*" OR "second-grade*" OR "grade 2" OR "grade two" OR "3rd-grade*" OR "third-grade*" OR "grade 3" OR "grade three" OR "4th-grade*" OR "fourth-grade*" OR "grade 4" OR "grade four" OR "5th-grade*" OR "fifth-grade*" OR "grade 5" OR "grade five" OR "6th-grade*" OR "sixth-grade*" OR "grade 6" OR "grade six" OR "intermediate general" OR "secondary education" OR "secondary school*" OR "7th-grade*" OR "seventh-grade*" OR "grade 7" OR "grade seven" OR "8th-grade*" OR "eight-grade*" OR "grade 8" OR "grade eight" OR "9th-grade*" OR "ninth-grade*" OR "grade 9" OR "grade nine" OR "10th-grade*" OR "tenth-grade*" OR "grade 10" OR "grade ten" OR "11th-grade*" OR "eleventh-grade*" OR "grade 11" OR "grade eleven" OR "12th-grade*" OR "twelfth-grade*" OR "grade 12" OR "grade twelve" OR "junior high*" OR "highschool*" OR "preuniversity" OR "pre-university")

Results: 144.641

1 AND 2 AND 3 120 results

Limit to 1990-..

120

results

SCOPUS

#1 curriculum reforms

TITLE-ABS-KEY({curriculum} W/1 ({renewal} OR innovat* OR reform* OR {change}))

Results: 3.865

#2 State

TITLE-ABS-KEY({national} OR {state} OR region* OR provinc* OR countr* OR federal*)

Results: 8.244.482

#3 K12

TITLE-ABS-KEY({elementary education} OR "elementary school*" OR {primary education} OR "primary school*" OR "K-12*" OR {K12} OR "1st-grade*" OR "first-grade*" OR {grade 1} OR {grade one} OR "2nd-grade*" OR "second-grade*" OR {grade 2} OR {grade two} OR "3rd-grade*" OR "third-grade*" OR {grade 3} OR {grade three} OR "4th-grade*" OR "fourth-grade*" OR {grade 4} OR {grade four} OR "5th-grade*" OR "fifth-grade*" OR {grade 5} OR {grade five} OR "6th-grade*" OR "sixth-grade*" OR {grade 6} OR {grade six} OR {intermediate general} OR {secondary education} OR "secondary school*" OR "7th-grade*" OR "seventh-grade*" OR {grade 7} OR {grade seven} OR "8th-grade*" OR "eight-grade*" OR {grade 8} OR {grade eight} OR "9th-grade*" OR "ninth-grade*" OR {grade 9} OR {grade nine} OR "10th-grade*" OR "tenth-grade*" OR {grade 10} OR {grade ten} OR "11th-grade*" OR "eleventh-grade*" OR {grade 11} OR {grade eleven} OR "12th-grade*" OR "twelfth-grade*" OR {grade 12} OR {grade twelve} OR "junior high*" OR "highschool*" OR {preuniversity} OR {pre-university})

Results: 211.459

1 AND 2 AND 3 228 results

Limit to 1990-.. 216 results

APPENDIX 2: TERMINOLOGY

Jurisdiction

The nation, state, province or district in which the curriculum reform takes place (for example: China (nation) or Illinois (state))

Methodology

Quantitative, (Quasi-)experiment, Qualitative, Mixed Methods

Context

The purpose of the reform, the period in which the reform took place and the scope of the reform (the overall curriculum; educational goals, learning objectives, subject renewal, creation of new subjects, content/topic renewal, number of hours per subjects).

Type of the reform

General curriculum reform ; reform of subjects (which subject)

Curriculum (de-)regulation

Curriculum regulation refers to governing education through *directives at input* (e.g. attainment goals, standards) and *output level* (e.g. national exams, standardized tests, inspectorate), leading to limited room for curriculum decision making at the school level. Curriculum deregulation reflects governing education by staying away from control at the input and output level and giving room for curriculum decision making at school level (Kuipers, Nieveen & Berkvens, 2013)

Curriculum overload

Curriculum overload, also referred to as “curriculum expansion” and “curriculum overcrowding”, has been identified as a challenge in many jurisdictions due to the increasing number of new demands for schools to address. Curriculum overload with these new demands is regarded as problematic because it typically results in teachers and students giving superficial coverage of broad subjects resulting in “more learning” rather than “deep learning”.

Time lag dilemma

Curriculum development can be perceived as the permanent search for qualitative improvement for relevance, in response to changes in society (Bude, 2000). However, when new social, economic and individual needs on education are identified, the changes in education are likely to fall behind the changes taking place in the real world.

Quality of curriculum content: Focus, Rigor and Coherence

Focus: A focus on in-depth learning of a few topics instead of shallow learning of many topics of a subject domain

Coherence: A characteristic of curriculum indicating the extent to which the curriculum aims and content, as well as textbooks, teaching methods, and assessment are all aligned and reinforce one another. Organization of contents according to the sequence and continuity of learning within a given knowledge domain or subject over time (vertical articulation to improve coherence) and the scope and integration of curricular contents from different knowledge domains within a particular grade level (horizontal articulation or balance to develop integration between subjects, disciplines or knowledge domains).

Rigor: A curriculum that aims at developing conceptual understanding, procedural skills and fluency of application of concepts.

Equity and opportunity of learning

A curriculum that takes care of the different needs of students and provides opportunities for learning of all students.

Planning of effective implementation

For redesigned curriculum to be effectively implemented, countries often start designing its implementation plan, to ensure a timely alignment between intended curriculum and implemented curriculum. The process will require preparation, planning, monitoring and adaptation, and countries take different implementation strategies to consider what actions to take and sequencing of such action

APPENDIX 3: SELECED RESEARCH

Author	Title	year	jurisdiction	design	nr of subjects in the study	type of reform	quality of curriculum content	equity & opportunity of learning	effective implementation
Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L.	The Aftermath of Accelerating Algebra: Evidence from District Policy Initiative	2014	USA	(Quasi-) experiment	194425 students	Reform of subject (algebra)	No	Yes	No
Hand, B., Therrien, W., & Shelley, M.	Examining the Impact of Using the Science Writing Heuristic Approach in Learning Science: A Cluster Randomized Study	2013	USA	(Quasi-) experiment	48 schools (24 exp/24 ctrl), 3801 students	Reform of subject (science)	Yes	Yes	No
Somel, R. N. & Nohl, A-M.	Social Change, Competition and Inequality: Macro Societal Patterns Reflected in Curriculum Practices of Turkish Schools	2015	Turkey	Qualitative	5 schools	General curriculum reform	No	No	Yes
Ramberg, M.R.	What makes reform work? -- school-based conditions as the predictors of teachers' changing practice after a national curriculum reform	2014	Norway	Quantitative	738 teachers	General curriculum reform	No	No	Yes
Shein, P. P., & Tsai, C	Impact of a scientist-teacher collaborative model on students, teachers, and scientists	2015	Taiwan	Mixed methods	1 school, 2 classes, 35 students (exp), 34(ctr)	Reform of subject (science)	Yes	No	No
Feniger, Y.	Jewish ethnicity and educational opportunities in israel: Evidence from a curricular reform	2015	Israel	Quantitative	26869 students	General curriculum reform	No	Yes	Yes
Yin, H., Lee, J. C., & Wang,	Dilemmas of leading national curriculum reform	2014	China	Qualitative	4 schools	General curriculum reform	No	No	Yes

Author	Title	year	jurisdiction	design	nr of subjects in the study	type of reform	quality of curriculum content	equity & opportunity of learning	effective implementation
W.	in a global era: A chinese perspective								
Homer, M., Ryder, J., & Donnelly, J.	Sources of differential participation rates in school science: The impact of curriculum reform	2013	England	Quantitative	not provided (large scale, based on existing databases)	Reform of subject (science)	No	Yes	No
Cheung, A. C. K., & Wong, P. M.	Factors affecting the implementation of curriculum reform in hong kong: Key findings from a large-scale survey study	2012	Hongkong	Mixed methods	270 schools	General curriculum reform	No	No	Yes
Sargent, T. C.	New curriculum reform implementation and the transformation of educational beliefs, practices, and structures in Gansu province	2011	China	Quantitative	3387 students; 2991 teachers; 332 principals; 20 administrators (total)	General curriculum reform	No	No	Yes
Eick, C. J., Dias, M., & Smith, N. R. C.	Middle school students' conceptual learning from the implementation of a new NSF supported curriculum: Interactions in physical Science™	2015	USA	Quantitative	1 teacher, 66 students	Reform of subject (physical science)	Yes	No	No
Kirkgoz, Y.	Curriculum innovation in turkish primary education	2008	Turkey	Mixed methods	50 teachers	Reform of subject (English)	No	No	Yes
Kirkgoz, Y.	A case study of teachers' implementation of curriculum innovation in english language teaching in turkish primary education	2008	Turkey	Qualitative	32 teachers	Reform of subject (English)	No	No	Yes
Dahsah, C., & Coll, R. K.	Thai grade 10 and 11 students' understanding of stoichiometry and related concepts	2008	Thailand	Mixed methods	97 students	Reform of subject (chemistry)	Yes	No	No
Carroll, W. M.	Results of third-grade students in a reform curriculum on the illinois state	1997	USA	Quantitative	26 schools	Reform of subject (mathematics)	Yes	Yes	Yes

Author	Title	year	jurisdiction	design	nr of subjects in the study	type of reform	quality of curriculum content	equity & opportunity of learning	effective implementation
	mathematics test								
Vulliamy, G., & Webb, R.	The implementation of the national curriculum in small primary schools	1995	England	Qualitative	50 schools	General curriculum reform	No	No	Yes
Meyer, T., & Thomsen, S. L.	How important is secondary school duration for postsecondary education decisions? evidence from a natural experiment	2016	Germany (Saxony-Anhalt)	Quantitative	1246 students (total)	General curriculum reform	Yes	Yes	No
Kim, D., & Bolger, M.	Analysis of Korean elementary pre-service teachers' changing attitudes about integrated STEAM pedagogy through developing lesson plans	2016	Korea	Mixed methods	119 teachers	Reform of subject (STEAM)	No	No	Yes
Lam, S. Y., So, J. C. H., & Ng, K. W.	Hong Kong secondary education reform and its impact on social and cultural awareness	2014	Hongkong	Quantitative	3626 students	General curriculum reform	Yes	No	Yes
Akar, E. O.	Constraints of curriculum implementation as perceived by Turkish biology teacher	2014	Turkey	Mixed methods	128 teachers	Reform of subject (biology)	Yes	No	Yes
Tong, S. Y. A.	Lessons learned? school leadership and curriculum reform in Hong Kong	2010	Hongkong	Qualitative	9 schools	Reform of subject (English)	No	No	Yes
Şahin, I.	Curriculum assessment: Constructivist primary mathematics curriculum in Turkey	2009	Turkey	Quantitative	785 (total)	Reform of subject (maths)	Yes	No	No
Tam, V. C. W.	Homework involvement among Hong Kong primary school students	2009	Hongkong	Quantitative	2361 students	General curriculum reform	Yes	No	No
Sanders, M., & Ngxola, N.	Identifying teachers' concerns about teaching evolution	2009	South Africa	Qualitative	125 teachers	Reform of subject (biology)	No	No	Yes

Author	Title	year	jurisdiction	design	nr of subjects in the study	type of reform	quality of curriculum content	equity & opportunity of learning	effective implementation
, J., & Donnelly, J.	Applied science in the english school curriculum: The meaning and significance of 'vocationalization'	2009	England	Mixed methods	20 schools (interviews), 149 schools (questionnaire); 248 students (questionnaire), database with test scores (nr not provided)	Reform of subject (science)	No	No	Yes
Nonoyama-Tarumi, Y., & Bredenberg, K.	Impact of school readiness program interventions on children's learning in cambodia	2009	Cambodia	(Quasi-) experiment	473 (exp), 458 (ctr) students	General curriculum reform	Yes	Yes	Yes
Khaniya, T., & Williams, J. H.	Necessary but not sufficient: Challenges to (implicit) theories of educational change: Reform in nepal's primary education system	2004	Nepal	Quantitative	3534 students	General curriculum reform	No	Yes	Yes
Hacker, R. G., & Rowe, M. J.	The impact of a national curriculum development on teaching and learning behaviours	1997	England	Mixed methods	60 teachers	Reform of subject (science)	Yes	No	Yes
Raj, S. N. R., Sen, K., Annigeri, V. B., Kulkarni, A. K., & Revankar, D. R.	Joyful learning? the effects of a school intervention on learning outcomes in karnataka	2015	India (Karnataka)	Quantitative	1817 students;	General curriculum reform	Yes	Yes	Yes
Sargent, T. C.	Revolutionizing ritual interaction in the classroom constructing the chinese renaissance of the twenty-first century	2009	China	Mixed methods	30 classroom observations; 936 students (questionnaire)	General curriculum reform	Yes	No	Yes
King, C.	The response of teachers to new subject areas in a National Science Curriculum: The case of the earth science component	2001	England	Quantitative	quantitative 174 teachers	Reform of subject (earth science)	Yes	No	Yes
Lee, J.C., Yin, H.B., Zhang, ZH & Jin, Y.	Teacher Empowerment and Receptivity in Curriculum Reform in China	2011	China	Quantitative	1646 teachers	General curriculum reform	No	No	Yes

Author	Title	year	jurisdiction	design	nr of subjects in the study	type of reform	quality of curriculum content	equity & opportunity of learning	effective implementation
MacLean, J., Mulholland, R., Gray, S. & Horrell, A.	Enabling Curriculum Change in Physical Education: The Interplay between Policy Constructors and Practitioners	2015	Scotland	Mixed methods	88 teachers (questionnaire) 17 teachers (interview)	Reform of subject	No	No	Yes
McCaffrey, D.F., Hamilton, L.S., Stecher, B.M., Klein, S.P., Bugliari, D. & Robyn, A.	Interactions among instructional practices, curriculum, and student achievement: The case of standards-based high school mathematics	2001	USA	Quantitative	5426 students, 182 teachers, 226 courses	Reform of subject (mathematics)	Yes	No	Yes
Sun, Z. & Leung, B.W.	A Survey of Rural Primary School Music Education in Northeastern China	2014	China	Quantitative	28 schools, 128 teachers, 674 students	Reform of subject (music)	No	No	Yes
Turner, C.E.	Professionalism and High-Stakes Tests: Teachers' Perspectives when Dealing with Educational Change Introduced through Provincial Exams	2006	Canada (Quebec)	Quantitative	153 teachers	Reform of subject (ESL)	Yes	No	Yes
Wong, P-M & Cheung, A.	The Adoption Features of Government Initiatives for the Curriculum Reform in Hong Kong Schools	2015	Hongkong	Mixed methods	209 principals; school curriculum specialists 125, learning area heads 1412, 7869 teachers	General curriculum reform	No	No	Yes