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Gender differences in learning styles: a narrative review and quantitative meta-analysis

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Abstract. This article reviews research on gender and learning styles of students, 18 and older, conducted after 1980. Curry's onion model (1983) is used to classify definitions of learning styles and to reconstruct the theoretical frameworks used. The extent to which learning style is considered stable or variable in different learning contexts determines its position in the model. Most studies used theoretical frameworks that belonged in the middle or outer layers of the model. This location indicates the strong influence of learning context on women's and men's learning styles. While there were differences between learning styles, research designs rarely included learning contexts.

In addition to the narrative review, we performed a quantitative meta-analysis on two instruments (Kolb's Learning Style Inventory and Entwistle's Approaches to Studying Inventory) to determine the direction and magnitude of gender differences in various samples. A search for these two instruments resulted in 26 studies for which the necessary statistics were available. On Kolb's instrument, the results showed that men were more likely than women to prefer the abstract conceptualisation mode of learning. On Entwistle's ASI a difference was found on the affective components of approaches to studying.

Introduction

Extensive empirical research has been conducted in the field of education and gender since the mid 1960s. Research results show that women in most Western countries have not been at a disadvantage with respect to men in the sense of leaving school with less education since about 1980 (Acker *et al.* 1984, Dronkers 1980, Wilson 1991). However, they still leave school with fewer opportunities for continuing their education and poorer prospects on the labour market. Especially the under-representation of women in mathematics and science and in technical courses remains an intractable problem (Eccles *et al.* 1986, Rennie *et al.* 1991).

Empirical research on gender and education in mathematics and science focuses mainly on school-internal factors, particularly the role of teachers, teaching methods and the scope of education (Burton 1990, Chipman *et al.* 1985, Fennema and Leder 1990, Volman *et al.* 1993). The emphasis on teaching methods as a variable that may affect both the choices and the success of women studying mathematics and science is closely related to learning processes. Concepts referring to these processes include learning styles, cognitive styles, approaches to studying or learning strategies.[2] Several research projects use these concepts to explain gender differences in study choices (Bar-Haïm and Wilkes 1989, Dippelhofer-Stiem 1989) or performance (Matthews 1991, Thompson and O'Brien 1991).

Gender inequality in educational choices and careers appears to be partially due to the way students learn.

This article presents the findings of a review of research on gender and learning styles of students, 18 and older, after 1980. The main research question is whether men and women use different learning styles. If they do, to what extent do their learning styles differ and what do these differences involve? A second question concerns the way gender differences are conceptualised and the results are interpreted. We are especially interested in assumptions about the role of education. Following a brief description of the methods, this article begins by examining the theoretical frameworks of the studies our search retrieved. We subsequently focus on the extent of these gender differences by presenting the results of a quantitative meta-analysis. We perform a meta-analysis on two of the learning style instruments discussed in the narrative review. In the last part of this article, we relate the results of the narrative review and the meta-analysis to questions concerning gender inequality in education.

Throughout this article, gender differences are discussed in terms of differences between the mean scores of two groups. These stereotypes are by no means intended to apply to individuals. While gender differences are possible, individual differences within these groups may actually exceed those between the groups (Halpern 1992). This situation can result in a problem. Associating men and women with modes of learning independent from (educational) contexts might be interpreted by teachers as applying to all men and women, thus setting a self-fulfilling prophecy in motion.

Methods[3]

We conducted a search for research on gender differences in learning styles after 1980 through select databases, using a wide variety of search terms. Studies were included in the review when the sample included both men and women, when the mean age was 18 or older and a direct relationship between gender and learning styles was considered. Besides, 'single' studies using terms and instruments which no other studies are using, were not discussed in the narrative review. The available studies were read according to a reading list that reflected the research questions. The narrative review served to highlight current theoretical frameworks on gender differences in learning.

A second search was conducted to perform a quantitative review using meta-analytic techniques (Light and Pillemer 1984). Using the scores of men and women on the same instrument in different studies seemed the most reliable method of performing a meta-analysis. In the narrative review three instruments are used more than once. These are Kolb's Learning Style Inventory (LSI), (1976, 1984), Entwistle's Approaches to Studying Inventory (ASI) (1981), and Witkin's Group Embedded Figures Test (1979). The first two instruments were included in the meta-analysis. The test of field (in)dependence was omitted because field (in)dependence concerns performance rather than preference (Caplan 1984),

therefore the test is not valid (Prosser Gelwick 1985).

The second search resulted in 60 authors using Kolb's Learning Style Inventory and 22 authors using Entwistle's Approaches to Studying Inventory. Because most of these authors did not publish statistics regarding gender differences, we wrote to them to request the necessary statistics. Unfortunately, a number of the authors no longer had access to the data or did not code the data by sex. Nineteen studies using the LSI and seven studies using the ASI were suitable for the meta-analysis. D-scores of gender on the LSI and ASI scales are calculated and homogeneity is considered. The effect of background variables (age and discipline), when available, is tested in regression analyses. This technique is only used on the data of Kolb's LSI, as not enough studies used Entwistle's ASI.

One of the problems in a review concerns the possible inclusion of fundamentally flawed studies (Light and Pillemer 1984). The studies in this review were closely read and appeared to be of good quality. Besides, as it concerned almost only material published in scientific journals, peer review has taken place. We assumed this to be a sufficient quality control.

Conceptualising gender differences

This section focuses on the dimensions where gender differences appeared in the studies retrieved by our first search. Curry's onion model (1983) serves as a vehicle to produce a descriptive reconstruction of the (frequently implicit) theoretical assumptions in the studies. The onion model contains three layers of theories and concepts concerning learning styles. The extent to which a theory assumes external (educational) factors influence the learning styles determines its position in the onion. In the inner layer a given learning style is viewed as a fairly fixed personality trait; it is not considered sensitive to variables within the educational system. In the outer layer though, theories assume external factors influence learning styles. The onion's middle layer contains learning style concepts that are considered more stable than those in the outer layer, but nevertheless subject to modification according to the learning context. In the retrieved studies, choices of instrument or definitions of the concepts made assumptions about gender and learning styles explicit. These indicators determined the appropriate layer of the onion for discussing the study.

Firstly, we discuss the most important theory belonging in *the inner layer*. Witkin's theory on field (in)dependence is frequently used in research on gender and learning. Witkin defined field independence as using oneself as the primary referent for processing information and field dependence as relying on outside referents (1979). The field (in)dependent mode of processing information is viewed as a stable characteristic, placing this theory in the inner layer of the onion model. Witkin's research results (1979) showed statistically significant gender differences on the dimension of field (in)dependence as measured by the Group Embedded Figures Test (GEFT). The studies (from after 1980) obtained through the search using the GEFT, however, showed women to be only slightly more field dependent

than men. None of the studies reported a statistically significant difference (Chatterjea and Paul 1982, Myer and Higgins 1984, Petrakis 1981). Lotwick *et al.* (1981) used the rod-and-frame test of field (in)dependence. They found field dependence to be significantly greater among female polytechnic students than among their male counterparts.

Theories in the inner layer of the onion model assume learning styles to be stable across time and contexts. The logical implication would be for the educational system to accommodate these stable learning styles of men and women. Because only one study found a statistical significant gender difference on the field (in)dependence dimension, accommodating education to field (in)dependent individuals is unlikely to have much impact on gender inequality in educational careers.

In *the middle layer*, Kolb's theory on experiential learning figures prominently in the field of gender and learning. Experience plays a key role in learning and individuals differ in the ways they approach various tasks and use experience. Some prefer learning through experimentation, others prefer to start with observation. Kolb defines learning style as a student's fairly consistent response to and use of stimuli in the context of learning (Hayden and Brown 1985). This definition places his theory in the middle layer of the onion model, consequently all studies using the theory (and the instrument) as well. The studies in our search reported various results on Kolb's LSI. Kolb (1984) found that women tended to prefer concrete learning styles, whereas men were more likely to opt for abstract conceptualisation modes of learning. Baxter Magolda (1987) reported a similar result, but her findings were not statistically significant. Vernon-Gerstenfeld (1989) found that women were slightly more reflective in their learning style than men, but again, the differences were not statistically significant. She observed an interaction effect with the LSI. Her sample related adoption of computers to women's (rather than men's) learning styles. She argued that because more women than men in her sample had studied sciences, the women tended to be more abstract in their mode of thinking and thus quicker to adopt computers. Hayden and Brown (1985) observed no gender differences at all. Nevertheless, in Prosser Gelwick's review (1985), more women appeared on the concrete end and more men on the abstract end. She ascribed this finding to the effects of child-rearing practices on cognitive development. Baxter Magolda (1989) remarked that educators' learning preferences often imply a preference for certain teaching methods, which benefits some students while placing others at a disadvantage. A more desirable learning environment in the likelihood of diversity within a class would enhance and value equally all modes of learning.

Another study with assumptions belonging in the middle layer was conducted by Dippelhofer-Stiem (1989). We discuss this study because it is one of the rare studies on gender differences and the development of learning styles in various contexts. Dippelhofer-Stiem performed a longitudinal study in five European countries (Austria, Germany, the Netherlands, former Yugoslavia and Poland) on research oriented learning styles. She defined the relatively consistent research oriented learning styles as involving critical thinking, autonomy, exploration, a

deep approach, relating ideas and intrinsic motivation. In the first semester, men and women showed heterogeneous results on this style, meaning gender differences differ in magnitude and direction in each subject and country. Towards the end of their studies, however, in all countries and disciplines, male respondents displayed a more developed research oriented learning style. In an effort to explain observed gender differences, Dippelhofer-Stiem noted that women's value systems differ from those of men in that they are more socially oriented and select their courses accordingly. She assumes this tendency results from tradition. Still, this assumption does not explain why the results of the first semester were heterogeneous, while the gender differences in the ninth semester were homogeneous. Because men scored higher than women on this learning style in the ninth semester, it might be concluded that, despite all the contextual differences, in general, learning environments are more stimulating to men in terms of developing this research oriented learning style. Which aspects of the university could have impeded women's development of this learning style, remains unknown.

In addition to co-ordinating teaching and learning styles, challenging both female and male students to use other modes of learning is a possible implication for education of the studies in the middle layer. Interaction effects were found, but the middle layer did not contain systematic empirical investigations of factors affecting the gender-related elements of learning.

The difference between the middle and outer layers of the onion model is not always clear. Although none of the studies assume that learning processes result exclusively from the learning environment, theories in *the outer layer* tend to emphasise learning environment more than those in the middle layer. Instruments such as the Inventory of Learning Processes (ILP) (Schmeck 1983), the Study Behaviour and the Study Process Questionnaire (SBQ and SPQ) (Biggs 1987) and the Approaches to Studying Inventory (ASI) (Entwistle 1981) measure learning strategies.

Because learning styles (strategies or processes) in most studies in the outer layer consisted of several dimensions, Table 1 summarises observed gender differences. A few trends appeared. Men scored higher on scales measuring extrinsic motivation. They are more often grade oriented and competitive. Men also scored higher on negative attitudes to studying and on the neuroticism and dependence scales of the SBQ. Although not all studies showed differences on the intrinsic motivation scales, in case of differences women scored higher. On the deep approaches to learning and achievement motivation: in case of differences men scored higher on these scales. Women seemed to score higher than men on the surface approach, although men scored higher on the reproducing scale of the SBQ.

Some interaction effects appeared in the studies fitting in the outer layer. Watkins and Hattie (1981) found a significant interaction effect of gender and department on the Inventory of Learning Processes. Apparently, men and women within a given department used different study approaches or learning processes. Miller *et al.* (1990) discussed the interaction effect of gender and approach to learning on grades. Women's grades were partly determined by negative attitudes whereas men's grades were not. Speth and Brown (1990) observed interactions

Table 1. Research results on subscales of various instruments in the outer layer (the observed differences are statistically significant ($p \leq .05$))

Subscale	Brief description	women higher	men higher	no diff.
Deep approach (ASI)	Active questioning in learning		3	2
Deep processing (ILP)	Meaningful as opposed to superficial information processing		3	6
Use of evidence (ASI)	Relating evidence to conclusions		3	2
Inter-relating ideas (ASI)	Relating to other areas of knowledge	3		2
Meaningful learning (SBQ)	Read widely, inter-relate with previous relevant knowledge			6
Versatile style (short-ASI)	A combination of meaning, comprehension and detailed learning			1
Study success (short-ASI)	A combination of versatile style and well-organised study habits			1
Elaborative processing (ILP)	The ability to relate new and old information using a variety of techniques			3,6
Intrinsic motivation (ASI)	Interested in learning for learning's sake	3		2
Intrinsic motivation (SBQ)	University study as an end in itself	6		3
Internalising motivation (SPQ)	Intrinsic interest, integrating various subjects	6		
Internalising strategy (SPQ)	Read widely, with maximal understanding	6		3
Internality (SBQ)	Uses internal, self-determined standards of truth not external authority			6
Openness (SPQ)	Student sees university as a place where values are questioned	6		
Pathological style (short-ASI)	A combination of poor study approaches			1
Surface approach (ASI)	Preoccupation with rote learning	3		2
Surface level processing	Reproductive, memorising text	5		
Fact retention (ILP)	The ability to retain detailed factual information			3,6
Rote learning (SBQ)	Centres on facts and details and rote learns them			6
Utilising strategy (SPQ)	To avoid failure and to focus on minimal content		6	3
Reproducing scale (SBQ)	Memorising facts		6	
Methodical study (ILP)	Repetitive, drill and practice habits	6		
Study skills (SBQ)	Works consistently, reviews regularly			6
Organisation strategy (SPQ)	Good planning, effective use of time	3		
Independent learning styles	Preference for working alone, not asking for help	4		
Syllabus boundness (ASI)	Relying on staff to define learning tasks			2,3
Fear of failure (ASI)	Anxiety about possible academic failure	3		2
Test anxiety (SBQ)	Worries about tests, exams, fear of failure			6
Neuroticism (SBQ)	Overwhelmed and confused by academic work		6	
Dependence (SBQ)	Needs class structure, rarely questions lectures		6	
Extrinsic motivation	Interest in courses for the qualifications they offer		2	

Table 1. Continued

Subscale	Brief description	women higher	men higher	no diff.
Instrumental motivation (SPQ)	Studying to pass courses, earn a degree and get a job		3,6	
Pragmatism (SBQ)	Grade oriented		6	
Achievement motivation (ASI)	Competitive and confident		3	2
Achievement motivation (SPQ)	Competitive approach		3	6
Achievement strategy (SPQ)	Close orientation to course outlines			6
Strategic approach (ASI)	Awareness of implications of academic demands made by staff		3	2
Negative attitudes to studying (ASI)	Lack of interest and application		2,3	
Disorganised study methods (ASI)	Unable to work regularly and effectively			2,3
Globetrotting (ASI)	Over ready to jump to conclusions			2,3
Comprehension learning (ASI)	Readiness to map out subject area and think divergently		3	2
Operation learning (ASI)	Emphasis on facts and logical analysis		2	3
Improvidence (ASI)	Over cautious reliance on details	3		2

Note: 1. Duckwall (1990, 2. Gledhill and Van der Merwe (1989), 3. Miller *et al.* (1990), 4. Schonberger (1981), 5. Van Rossum and Schenk (1984), 6. Watkins and Hattie (1981). ASI: Approaches to Studying Inventory (Entwistle 1981), short-ASI: Short Approaches to Studying Inventory (Entwistle 1981), SBQ: Study Behaviour Questionnaire (Biggs 1987), SPQ: Study Process Questionnaire (Biggs 1987), ILP: Inventory of Learning Processes (Schmeck 1983).

between type of assessment, approaches to studying, study preparation strategies and gender. They noted difficulty in establishing implications for education because goals might vary. If, for example, the goal is to achieve gender equality, instructors should consider whether an emphasis on objective assessment methods in natural sciences might affect women's and men's study preferences and choices. Murphy (1982) observed that men perform better in relation to women on objective (multiple choice) tests compared to other forms of assessment.

Most studies we situated in the outer layer recommended instructional processes, aimed at developing the desired approach to learning (such as a deep approach, intrinsic motivation and use of evidence). Interaction effects with department and type of assessment were found, but the studies we reviewed did not indicate *which* instructional variables mattered most.

The most remarkable result of this qualitative review concerns the lack of data on the influence of context variables on gender differences. In the middle layer, but also in the outer layer, the studies paid virtually no attention to, for example, teaching methods or learning tasks. Research in the field of gender and learning styles appears to consist primarily of descriptive studies. Explanations of the findings, whether empirically based or theoretically elaborated, were not provided.

We will now discuss the quantitative meta-analysis. In terms of empirical results, the narrative review resulted in a few consistent findings. Not only did these findings differ on several dimensions, but at times they were actually contradictory (see Table 1). Performing a meta-analysis on an instrument belonging to the middle

layer (Kolb's LSI) and on one belonging to the outer layer (Entwistle's ASI) might produce a more coherent picture of gender differences in learning styles.

Meta-analysis

Meta-analysis serves to integrate research findings of multiple studies on the same subject. Integrating studies from various disciplines and settings could indicate when and where gender differences appear. Both Kolb's LSI and Entwistle's ASI consist of various dimensions reflecting different aspects of learning styles. A meta-analysis on each of these scales will show the extent and direction of their gender sensitivity in the studies reviewed for this article.

In this meta-analysis we used the unbiased effect size d (Hedges and Olkin 1985, p. 81), which is the common estimator (g) corrected for a small sample bias. An effect size is the standardised difference between two groups (women and men in this case).

$$g = (M_{♀♀} - M_{♂♂}) / SD$$

(SD is the square root of the weighted average of the two variances).
We used Hedges and Olkin's random effects model (1985) to estimate the effect scores. In this model, the effect scores are assumed to have more than one underlying population parameter. This situation could apply to our sample of effect sizes because study characteristics (such as discipline) might affect the distribution of d-scores. A homogeneity test of the d-scores indicates whether more than one population parameter affects this distribution of the effect scores. In the event of heterogeneity, the observed variance is not fully explained by sampling variance. Artefacts can explain some of the observed variance, and moderator variables (other population parameters) explain the rest. One of the artefacts may be measurement error. Information on the reliability of the scales is available, consequently the effect scores are corrected for attenuation. Hedges and Olkin (1985) describe a statistical test of homogeneity. If a chi-square test produces a statistically significant coefficient Q, the distribution of d-scores is heterogeneous. Schwarzer's statistical package (1989) was used to analyse the data.

Kolb's Learning Style Inventory: results

Figure 1 shows the underlying model of experiential learning. The LSI is a nine-item self description questionnaire. Each item consists of four words. These words correspond to the four learning modes (Kolb 1984). Respondents describe themselves by ranking these four words. Their choices result in four scores on the scales as shown in Figure 1.

Nineteen studies were included in this meta-analysis. Only one author (Katz 1988) reported a reliability score. The other authors all considered the satisfactory

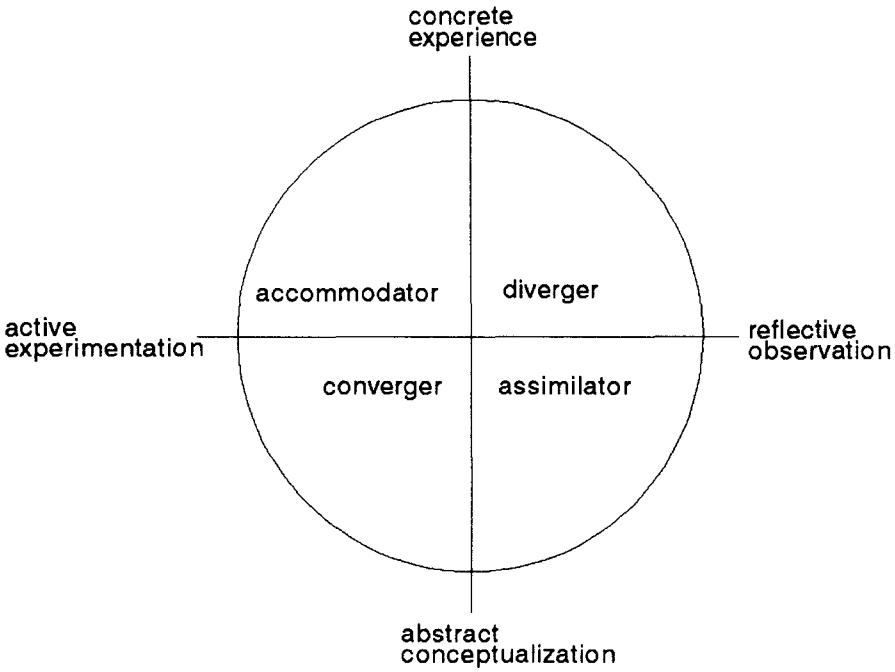

Fig. 1. Kolb's model of experiential learning.

reliability of the scales referring to Kolb's publication of reliabilities. Our data matrix used reliabilities as mentioned in Kolb's *Learning Style Inventory: Technical Manual* (1976) in case of the original inventory. Pinto and Geiger (1991) and Veres *et al.* (1991) provide reliability scores (internal consistency) based on Kolb's revised version (1984). Our data matrix used these reliability scores whenever the revised version was used.[4]

The meta-analysis reveals slightly lower scores for women on the Abstract Conceptualization scale. Men are more likely than women to start the learning process with abstract concepts. While a d-score or -0.16 is low (Cohen 1977), the confidence interval and the homogeneity of the variance of the d-scores indicate a reliable result. The d-scores on the remaining scales may be ignored (see Table 2). The heterogeneity of the distribution of d-scores on the Concrete Experience and the Reflective Observation scales suggest the possible influence of moderator variables.

The next step involved a search for variables affecting gender differences. Regression analysis was performed on the d-score as a dependent variable and a few background variables as independent variables.[5] Age was the only variable with a statistically significant correlation with the d-score on the Abstract Conceptualization ($r = -.59$, $p < .05$). Older women tended to be less abstract than older men, while younger women in the college environment were more abstract than younger men. Cluster analysis on the heterogeneous scales did not produce meaningful results.

Table 2. Effect sizes and homogeneity in the 'random effects model' after correction for unreliability on the LSI.

	d-score (s.d)	95%-confidence interval for d	Q
CE	.01(.10)	−0.19 to 0.21	50.50*
RO	.01(.08)	−0.15 to 0.17	49.83*
AC	−.16(.06)	−0.28 to −0.05	25.75
AE	.02(.07)	−0.12 to 0.15	28.47

Note: *significant nonhomogeneity at $p \leq .05$ according to a chi-square test. CE = Concrete Experience, RO = Reflective Observation, AC = Abstract Conceptualization, AE = Active Experimentation.

The conclusion on Kolb's LSI is that one scale of the instrument is to a small extent gender-sensitive: men score higher on the Abstract Conceptualization scale. It remains unclear which contextual factors influence the scores on the heterogeneous scales.

Entwistle's Approaches to Studying Inventory: results

The ASI is a 64-item self report questionnaire. The items are distributed into four learning orientations, consisting of 16 scales (see Table 1). The meaning and reproducing orientations reflect the distinction between deep and surface approaches (Marton and Säljö 1976a, 1976b). The other scales of the ASI measure achieving orientation as well as styles and pathologies. The items are scored on a scale from 'definitely agree' to 'definitely disagree'. Most authors reported reliabilities (Cronbach's α). The internal consistency varies a great deal as the same scales in different studies can range from .29 to .82. For a discussion on reliability (internal and test-retest), see Richardson (1990).

Table 3 shows d-scores, confidence intervals and information on the homogeneity of the studies in the meta-analysis on the ASI. On four of the 16 scales of the ASI (Surface Approach, Extrinsic Motivation, Disorganised Study Methods and Globetrotting) homogeneous results were found, two of these scales show a d-score of some substance. On the Extrinsic Motivation scale, a d-score of −.35 appeared, men are more extrinsically motivated compared to women. On the Surface Approach scale, women score slightly higher on the surface approach compared to men. Other small to medium d-scores (Cohen 1977, larger than ±0.20) appeared on the Intrinsic Motivation, the Fear of Failure and the Achievement Motivation scales. These d-scores were heterogeneously distributed, it is remarkable that on all three occasions affective concepts are involved (see Table 4). Women, in this sample of studies, apparently tend to experience more anxiety and to be more pessimistic than men about academic success. The results on the motivation scales show that women in this diverse sample seem to be more intrinsically motivated and men to be more extrinsically and achievement motivated.

Table 3. Effect sizes and homogeneity in the 'random effects model' after correction for unreliability on the ASI

	d-score s (s.d)	95%-confidence interval for d	Q
Deep approach (DA)	.04(.13)	−.21 to .30	36.5*
Use of evidence (UE)	−.07(.12)	−.31 to .17	36.5*
Relating ideas (RI)	.18(.12)	−.06 to .42	25.2*
Intrinsic motivation (IM)	.29(.20)	−.10 to .69	33.1*
Surface approach (SA)	.13(.09)	−.04 to .30	7.2
Syllabus boundness (SB)	−.13(.09)	−.31 to .05	16.9*
Fear of failure (FF)	.30(.08)	.13 to .46	11.3*
Extrinsic motivation (EM)	−.35(.05)	−.45 to −.26	5.0
Achievement motivation (AM)	−.21(.10)	−.41 to −.01	13.4*
Disorganised study methods (DS)	.03(.06)	−.09 to .14	3.1
Strategic approach (StA)	.17(.13)	−.09 to .43	11.8*
Negative attitudes to studying (NS)	.00(.18)	−.35 to .35	24.2*
Globetrotting (GL)	−.04(.09)	−.22 to .14	5.4
Comprehension learning (CL)	−.10(.09)	−.28 to .08	19.9*
Operation learning (OL)	.01(.15)	−.29 to .32	14.4*
Improvidence (Imp)	.17(.12)	−.06 to .40	15.3*

Note: *Significant nonhomogeneity at $p \leq .05$ according to a chi-square test.

Table 4. Effect sizes on the scales of the Approaches to Studying Inventory

No.	Study by	DA*	UE	RI	IM	SA	SB	FF	EM	AM	DS	StA	NS	GL	CL	OL	Imp
1	Miller *et al.*	−.17	−.31	.21	.13	.19	−.00	.30	−.26	−.43	.00	.34	−.16	.01	−.27	.00	.21
2	Gledhill *et al.*	.17	.05	.36	.10	−.13	−.25	.13	−.52	.00	−.17	.09	−.41	−.17	−.12	−.37	−.30
3	Clarke	−.11	.00	−.13	.03	.19	−.07	.38	−.55	−.39	.05	−.22	.10	.21	.11	−.03	.27
4	Coles								.12								
5	Watkins	.47	.29	.46	.77	.05	−.35	.39	−.49	−.10	.16	.24	.34	−.14	.18	.28	.26
27	Richardson	−.17	.37	.01		.35	.13	.38				.35			.00		−.03
28	Richardson	−.06	−.35	−.10		.04	.05	−.02							−.42		

Note: *Meaning of abbreviations see Table 3.

Artefacts and moderator variables influenced these results. One artefact concerned the use of instruments. Most studies used an adapted version of the ASI. A few used minor adaptations to correspond to their particular sample (e.g., Gledhill 1989). Richardson (1990) and Coles (1985) used shortened versions. Consequently, not every study reported statistics on all scales. Furthermore, the variability of the d-scores was probably enlarged by the different educational and regional settings in which the studies were conducted. We did not perform a regression analysis because of an insufficient number of studies.

Summary and discussion

This article reviewed theoretical and empirical findings in research on gender-related learning styles. The most important concept in *the inner layer* of the onion model was the field (in)dependence dimension of Witkin. Apart from one study, none of the reviewed studies showed statistically significant gender differences. In most studies in *the middle layer*, Kolb's theory on experiential learning was used. In the narrative review heterogeneous results were found. Meta-analysing this instrument resulted in a small consistent gender difference: men showed a greater preference than women for the abstract conceptualisation mode of learning. In *the outer layer* a gender difference appeared on the scales for extrinsic motivation. This difference also appeared in the meta-analysis. In all these different settings, men were more often interested in the courses for the qualifications they offer. Women on the other hand, are more often interested in learning for learning's sake. In the narrative review the deep and surface dimension turned out to be slightly gender sensitive. In several studies, men showed more often a deep approach to learning, women more often a surface or reproducing approach to learning. The meta-analysis did not show a substantial d-score on the deep approach scale. On the surface approach-scale only a small d-score appeared.

The question remains whether research on gender and learning can contribute to the discussion on gender inequality in education. We think it can. Some studies mention a link between the way students learn and gender differences in study choices and success. But the nature of this relationship was virtually never elaborated on, theoretically nor empirically. In this review we have shown the lack of investigation of the role of education in creating the differences in learning styles. Do certain learning styles lead to more study success, or is this only the case in a converging context? Considering the under-representation of women in mathematics and science: Do students choose their subjects according to their learning style or do the learning styles change according to the subjects they choose? In order to be able to draw conclusions on the processes involved in and the causes of gender differences in learning, it seems important to investigate the gender sensitive dimensions more thoroughly. These dimensions should not only be interpreted, but also empirically investigated, as resulting from interaction between factors outside and inside the school environment.

Notes

1. We would like to thank Joop Hox, Gonny Schellings, Jan Vermunt and the referees for their valuable comments on earlier drafts of this article.
2. In this article we generally use the term learning styles, because it is widely used in discussions on gender and learning. When a particular theory or author is discussed, we use the terminology of that particular theory or author.
3. More detailed information can be obtained from the authors.
4. The LSI (Kolb 1976) and its revised version (Kolb 1984) were criticised by Veres *et al.* (1991). The psychometric properties are not satisfactory, but according to the study by Veres *et al.* this is related

to the format. They conclude the revised version of the Learning Style Inventory 'may have considerable utility' (p. 149).

5. Detailed information on year of publication, mean age of the sample, whether it concerned a paper or an article and the major(s) of the sample can be obtained from the authors.

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*included in the meta-analysis.