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Gender and attitudes toward technology use: A meta-analysis

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ABSTRACT

Gender difference in the attitude toward technology use has long been a concern in education. The last meta-analysis on this issue covered the empirical studies up to about 20 years ago. Since then, technology use has increased exponentially, and many more empirical studies have examined this issue, but showed inconsistent findings. As a result, there is a lack of clear understanding about if such gender difference still persists. The purpose of this research is to re-examine this issue by meta-analyzing the empirical research studies on this issue in the last two decades, and to examine the potential moderators that may have contributed to the heterogeneity of the research findings. A total of 50 articles from 1997 to 2014 were identified and used in this meta-analysis. The findings indicated that males still hold more favorable attitudes toward technology use than females, but such different would be characterized as small effect sizes. The comparison between this study and the last meta-analysis of about two decades ago suggested that there was only minimal reduction in the gender attitudinal gap in general. But when the general attitude was broken down to different dimensions of attitude, the present study showed a reduction of gender difference in the dimension of *Affect* and *Self-efficacy*, but not in the dimension of *Belief*. The limitations of the study were noted, and the implications and future research directions were discussed.

1. Introduction

In the past few decades, the development of technology, especially technology related to computing and information, has been fast and furious, which has resulted in the deep infiltration of technology use in almost every aspect of people's daily lives, including, among other things, education and career choices. In the current society, learning and developing a good command of some basic technology skills has become a necessary part of one's ability for successful education and career, and technology competency has become very important and critical for a wide range of careers. In this age of ubiquitous usage of technology, one issue that has received considerable attention from many educational researchers and psychologists is related to the potential gender difference in technology use, and some possible psychological culprits for such gender differences (Liao, 1999; Whitley, 1997). The difference between males and females in technology use is also a topic of interest for society in general (Brown, 2016).

Over the years, there has been a stereotypical view concerning technology use and gender: relative to men and boys, women and girls might have more negative attitudes towards technology and technology use, and they would be less actively engaged in technology-related activities and behaviors, which could have contributed to the so-called "technological gender

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gap" (Canada & Brusca, 1993). However, as technology is becoming much more ubiquitous than ever, and technology is becoming an important part of life especially for young people, women's attitudes toward technology use could vary and change across time (Buccheri, Gürber, & Brühwiler, 2011). In recent years, there has been a growing interest in studying the gender groups' attitudes towards technology or computers (Ardies, Maeyer, & Gijbels, 2015; Potvin & Hasni, 2014; Teo, Milutinović, & Zhou, 2016). But the research findings from various individual studies about gender difference, or lack thereof, in the attitudes toward technology use have been inconsistent, making it difficult to draw any firm conclusion. For examples, Sáinz and López-Sáez (2010) reported more positive computer attitudes of boys than of girls, while Sáinz, Meneses, López, and Fàbregues (2016) concluded that young males did not show more positive attitudes towards technology use than girls. To address this issue of inconsistent research findings concerning possible gender difference in the attitudes toward technology use, studies of quantitative synthesis of the research literature on this issue were conducted many years ago (Liao, 1999; Whitley, 1997), suggesting that there were statistically significant gender differences in the attitudes toward technology use, with males having slightly more positive attitude toward technology use.

Over the past two decades, the society has witnessed an exponential growth in the technology development and infiltration in all aspects of the society, to the point that the society is now heavily dependent on technology to function, and technology has become an indispensable part of our daily lives. Given the rapid development and infiltration of technology in every aspect of the society over the last two decades, given the length of time after the last synthesis of research on this issue, and given the fact that many new studies have been conducted in this area since the last synthesis, it is unclear if the previous findings (e.g., Whitley, 1997) about this issue remain relevant and valid.

As discussed by some researchers (Tsai & Lin, 2004), as the technology use became more relevant and prominent in all aspects of the society and people's daily lives, concomitant changes might have occurred, and the gender differences related to technology use could have been narrowing. With such background, it is time that we revisit this issue and take a close look at the research findings after the last synthesis (Whitley, 1997) with regard to possible gender differences in the attitudes toward technology use. This study was designed for the purpose of providing an up-to-date quantitative synthesis about gender differences, or lack thereof, in the attitudes toward technology use.

1.1. Gender and attitudes toward technology use

On the issue of gender difference in attitudes toward technology use, the last two synthesis studies were done in late 1990s by Whitley (1997) and by Liao (1999), respectively. Because these two synthesis studies were so close to each other, it was expected that there should be considerable overlap in terms of the original studies included in these two meta-analytic studies. Unfortunately, a close look at these two studies revealed that one study (Liao, 1999) did not provide any meaningful information about the original studies included in the meta-analysis. In addition, this study exhibited a severe paucity of information on many other important aspects of a meta-analytic study (e.g., an extremely short and un-meaningful literature review, lack of information on why the moderator variables were used, total lack of literature review on these moderator variables, etc.). With the considerations of these serious defects, we decided that this conference meta-analysis paper needs to be excluded from our further consideration, and its findings would not be used for comparison purpose in our study. Consequently, in our study as described below, we only used the synthesis by Whitley (1997) for reference and comparison.

As shown in the synthesis by Whitley (1997), despite the inconsistencies among the individual studies, the research findings generally suggested that males showed more favorable attitudes toward technology use than females, confirming the general perception that gender differences existed with regard to technology use. Such gender difference might partially explain the gender gap in technology use and in the technology workforce. This observation and conclusion, however, may not remain valid after almost two decades, during which the society has witnessed the fast development and wide use of technology in all aspects of the society. As Tsai and Lin (2004) discussed, with the increasing ubiquity of technology and its prominence, changes related to technology use could have occurred; with more females acquiring more experiences related to technology, gender differences regarding technology use, including the attitudes toward technology use, could have been narrowing over the years.

Similar to the situation of inconsistent, and often contradictory, research findings about gender differences in attitudes towards technology use as summarized in Whitley (1997), studies in the recent two decades continue to provide mixed and inconsistent findings. On one hand, some researchers reported that males had more positive attitudes towards technology than do females (e.g., Chou, Wu, & Chen, 2011; Colley & Comber, 2003; Collis & Williams, 2001; Durndell & Haag, 2002; Durndell, Laithwaite, & Haag, 2000; Hasan, 2010; Jackson, Ervin, Gardner, & Schmitt, 2001; Kay, 2009; Kesici, Sahin, & Akturk, 2009; Ong & Lai, 2006). On the other hand, some other research studies showed evidence for supporting the opposite conclusion: males exhibited more *negative* attitudes toward technology use than their female counterparts (e.g., Chen & Tsai, 2007; Johnson, 2011; Price, 2006; Tsai & Lin, 2004). Furthermore, no gender differences in attitudes toward technology use were reported by others (e.g., Imhof, Vollmeyer, & Beierlein, 2007; North & Noyes, 2002). To understand these inconsistencies across the individual studies, it is necessary to conduct a systematic synthesis of these individual studies. Such a synthesis will not only help in shedding light on the general question of whether there remains a gender difference in the attitudes toward technology (if yes, how large such a difference is) as revealed by the studies conducted in the last two decades, but also help us to understand if some features of the individual studies may have contributed to the inconsistent findings across the individual studies.

1.1.1. Considerations for “attitudes” toward technology use

In the area of research for studying attitudes toward technology use, one critical issue is a lack of conceptual clarity for the construct of “attitude.” As Whitley (1997) discussed, one possible reason for the inconsistent findings in the research literature concerning attitudes toward technology use was that, very often, researchers treated attitudes toward technology use as a unitary construct, rather than as a multi-faceted construct. As a result, different studies might have operationalized the construct of “attitudes” in different ways by focusing on different aspects of the broad concept of “attitudes.” In research practice, researchers' operationalization of the attitudes toward technology use may have different focus, such as feelings and emotions (e.g., comfort, anxiety, personal liking) associated with technology use (e.g., Colley & Comber, 2003; Durndell & Haag, 2002; Jackson et al., 2001; Schottenbauer, Glass, Arnkoff, & Rodriguez, 2004), personal interest and enjoyment related to the use of technology (e.g., Bråten & Strømsø, 2006; Collis & Williams, 2001), personal beliefs about technology's social impact and usefulness (e.g., Collis & Williams, 2001; Huneke, 2002; Ong & Lai, 2006), or personal self-confidence or self-efficacy about one's ability in utilizing technology (e.g., Colley & Comber, 2003; Tsai & Tsai, 2010; Vekiri & Chronaki, 2008). Although these were generally conceptualized as representing the construct of “attitudes”, operationally, they were not necessarily the same, and they could function differently. For example, one may have a positive view or belief about the social impact and usefulness of technology, but he/she could have a low level of self-efficacy about his/her ability in utilizing technology. If these different components were treated as equivalent, or if “attitudes” were operationalized in different ways in different studies, it could have led to the inconsistent findings across the individual studies in this area.

In general, “attitudes” could be defined as “people's global evaluations of any object, such as oneself, other people, possessions, issues, abstract concepts, and so forth” (Petty, Fabrigar, & Wegener, 2003, p.752), and such “global evaluation” may consist of different facets: affect, beliefs, and self-efficacy (Whitley, 1997). After a review of the relevant research literature in the area of attitudes related to technology use, Whitley (1997) suggested that, in different studies, the different ways of operationalizing “attitudes” toward technology use could be categorized into five different, yet related, aspects: affect, beliefs, self-efficacy, mixed, and sex-role stereotype. Based on the descriptions of measures provided in each study about what aspect of “attitude” a particular study focused on, the present study categorized the “attitude” as used in each study into one the first four categories, as the last one (i.e., sex-role stereotype) was rare and almost non-existent in the studies we examined.

“Affect”, as related to technology use, is the emotional aspect of attitudes, and can be understood as “… To encompass emotions and relative transient moods and feelings” in performing technology-related tasks (Petty, Cacioppo, Sedikides, & Strathman, 1988), including constructs as anxiety, interest, enjoyment, fear and liking.

“Belief” is closely related to cognitive (cf. “affect” being emotional) aspect of attitudes, and could be construed as “an enduring organization of perceptions and cognitions about some aspect of the individual's world” (Krech & Crutchfield, 1948; as cited in Fishbein, 1962). Specifically related to technology use, “belief” refers to the extent to which one values technology use and its societal function.

“Self-efficacy” is generally known as the “generative capability in which cognitive, social and behavioral sub-skills must be organized into integrated courses of action to serve innumerable purpose” (Bandura, 1982). In terms of technology use, “self-efficacy” refers to peoples' belief in their own abilities to undertake a technology-related task successfully (McDonald & Siegall, 1992).

Some studies either did not provide sufficiently clear description about the aspects of “attitudes” assessed, or the items represented a mixture of different aspects. In this situation, it was not possible to divide the “attitude” into the three subtypes as described above. For the purpose of our synthesis, such case were categorized into “mixed” in terms of the aspects of attitude assessed in the study, following the suggestion of Whitley (1997).

1.1.2. Gender and attitudes toward technology use

The lack of clarity in defining and operationalizing “attitudes” toward technology use in research practice muddied the water of the empirical research findings, and made it difficult to draw any clear conclusions about gender differences in attitudes toward technology use. In our review, we attempted to organize and summarize the research studies based on the type of indicators (i.e., affect, belief, and self-efficacy) used in a study, as discussed below.

1.1.2.1. Gender difference in technology-related affect. Technology-related affect mainly assessed emotional responses to technology use (Whitley, 1997). Anxiety is a negative affection, which has been defined as an emotional fear when dealing with technology-related tasks (Chua, Chen, & Wong, 1999). A number of studies have tried to assess the difference between male and female about technology-related anxiety. There is a tendency to find greater anxiety among the females than males about technology use (Durndell & Haag, 2002; Jackson et al., 2001; Schottenbauer et al., 2004). Similarly, some research reported that, although there had been some evidence of increased participation by girls in the technology-related tasks, boys remained to show more interest and more enjoyment than girls (Colley & Comber, 2003) in technology use. But on the other hand, Sam, Othman, and Nordin (2005) found that gender was not related to technology-related anxiety, and there was no significant difference in the computer anxiety levels between gender groups.

1.1.2.2. Gender difference in technology-related beliefs. Technology-related beliefs including the cognitive components of acceptability and satisfaction of technology by professionals, positive and negative statements about technology and its positive effects on society (LaLomia & Sidowski, 1991). Considerable research has been conducted to assess whether gender is related people's cognition and perceived usefulness about technology use. For example, Collis and Williams (2001) found that boys were significantly more positive than girls with respect to the attitudes about the impact of computers on society. Ong and Lai (2006) came to similar conclusion. However, North and Noyes (2002) discussed that gender in general was not significantly related to cognitions towards computers. Their conclusions did not support the notion a gender gap, nor the literature that suggested that males had more positive cognitions than females.

1.1.2.3. Gender difference in technology-related self-efficacy. Technology self-efficacy is the belief that one has the sufficient abilities and skills to be successful when dealing with a technology related task (McDonald & Siegall, 1992). Numerous studies were conducted to investigate whether, and how, self-efficacy would influence or affect information technology use. Some research showed that males appeared to be more confident and knowledgeable in using technology-related skills (Yau & Cheng, 2012). However, some other research reported no gender differences in this aspect (Compton, Burkett, & Burkett, 2003), or, although less common, even findings to the contrary (Compton et al., 2003; Ray, Sormunen, & Harris, 1999). Cooper and Lucas (2006) and other researchers discussed that gender difference in self-efficacy might have resulted from differences of individual psychological states, behaviors and motivation. In the context of using technology, gender and one's self-efficacy could be related, based on one's perception of his/her own abilities as related to a particular task. Because self-efficacy would influence the choices that one would make, the effort that one would put forth, and one's persistence when facing obstacles and failure (Ackerman & Wolman, 2007), any gender difference in self-efficacy in technology use would undoubtedly have implications on gender groups' general attitudes toward technology use.

1.1.2.4. Cultural differences related to gender and technology use. Some research suggested possible differences related to attitudes toward technology across cultures and societies. The use of technology would not occur in a vacuum, but instead, in broader social and cultural contexts. For example, Collis and Williams (2001) discussed that cultural and regional difference was one critical factor in influencing people's acceptance and use of Internet-based learning resources. There was research suggesting that, in different countries, people might have different perceptions and views about information technology (Brosnan & Lee, 1998; Li & Kirkup, 2007). For instance, Li and Kirkup (2007) found that attitudes toward Internet usage between Chinese and British students were related to both culture and gender. Makrakis (1992) also showed that attitudes toward computers were culturally related. It is also plausible that people from different regions may have different understanding about technology use as a result of uneven economic development levels and differences in the accessibility of technology. Such factors may lead to differences in terms of how gender groups view technology use in different cultural contexts.

1.2. Study aims

In summary, as discussed above, with the rapid development of technology and technology's infiltration into all aspects of the modern society, technology competency has become more important and critical than ever in shaping one's career and life. With the long-standing concern about the gender gap in technology workforce, empirical research about possible gender differences in attitudes toward technology use has been active over the past few decades, but the inconsistent findings across the individual studies make it difficult to draw any clear conclusions about this issue. As a result, it remains unclear whether any meaningful gender differences exist in attitudes toward technology use. Since the quantitative synthesis of the relevant research literature (Whitley, 1997), almost twenty years has passed. Moreover, the period of the past twenty years has witnessed the fastest growth and development of computing and information technology. Because of these considerations, there is a strong need for a new quantitative synthesis of the relevant research literature concerning gender and attitudes toward technology use. The primary purpose of this study was to provide a quantitative synthesis of the relevant empirical studies on the issue of gender differences in attitudes toward technology uses. Such a quantitative synthesis of the empirical findings has the potential of providing insights into the relevant issues in the research related to attitudes toward technology use that, otherwise, would not be readily available or obvious from individual studies (Fan and Chen, 2001). Specifically, we focus on the following two research questions:

1. Are there gender group differences in attitudes toward technology use as reported in the previous empirical studies over the last two decades? How do the findings of the current meta-analysis compare with those reported from the previous meta-analysis many years ago?
2. What are the study features (e.g., attitude dimension, regions of sampling, age group of respondents, publication year, and publication type) that could partially explain the inconsistencies in the findings concerning the gender group differences in attitudes toward technology use across individual studies in the literature?

2. Method

2.1. Meta-analysis

Meta-analysis was described as “the analysis of analyses…, statistical studies of a large collection of analysis results from individual studies for the purpose of integrating the findings” (Glass, 1976, p. 3). In a meta-analysis, the seemingly inconsistent or contradictory findings from different individual studies were quantitatively synthesized based on a systematic approach. Effect sizes, "a metric of the magnitude of a result that is independent of scale of measurement and sample size" (Shaver, 1991, p. 87), from individual studies were accumulated, and the potentially relevant study features or characteristics were recorded. Quantitative analyses were conducted to explore how the study features might have contributed to the inconsistencies of the findings across individual studies (Shih & Fan, 2009).

2.2. Source of meta-analytic sample

Google Scholar, ERIC, Taylor & Francis Online, PsycInfo, SAGE, ScienceDirect, ProQuest databases were searched for empirical studies, both published journal articles and book chapters, or unpublished conference papers or dissertations, involving gender and technology use, by using the following key words: gender, sex, attitudes, computer, internet, e-learning, online learning, web-based learning, technology. While searching for the articles, we narrowed the search for the years 1997 onward to 2014 by using the key words either singly or in different combinations, and articles and papers after 2014 were not included in this study.

Initially, we identified about 500 research papers (either those published in journals, or unpublished conference reports or dissertations) that could be relevant for inclusion. For those 500 reports, after reading the abstracts, we narrowed our research to about 180 studies as being relevant to our topic. We had to further read the contents of these 180 articles to make sure that a study should be selected. The inclusion criteria were (1) a study must have compared and/or reported gender groups' attitudes about technology, technology use, computers, etc., and (2) the study must have reported sufficient statistics that would allow us to derive the effect size between gender groups (e.g., gender groups' means and standard deviations, or other information such as *t* statistic or *F* statistic for testing gender group difference on attitudes). The final sample of studies that were usable for our meta-analysis included 50 independent studies. See Appendix. The remaining articles were excluded for different reasons. For example, some did not compare gender differences towards technology, or they compared gender differences not for attitude, but for other things. There were some articles that did not report sufficient statistics for us to include into the meta-analysis. In such cases, we made the effort in contacting the original authors for obtaining more information, but did not receive responses.

From these fifty studies, we identified 87 comparisons between female and male groups in terms of their attitudes towards technology use, as some studies included more than one independent samples, and some reported more than one type of attitude towards technology use (e.g., affect, belief, and/or self-efficacy). These eighty-seven effect sizes from the fifty studies were used in the analysis reported below.

2.3. Coding of study features as variables

As we expected from our literature review, the definitions of attitude were diverse across the individual studies. After careful consideration of the variety of definitions for "attitude" described in different studies, we grouped the attitude type into four dimensions (affect, belief, self-efficacy, mixed), as discussed in Whitley (1997). Our variable of analysis interest is the difference in attitudes between male and female groups towards technology use. To understand what might have contributed to the inconsistent gender differences across different studies, we coded eight salient study features: (a) study ID, a number to identify each study; (b) sample size of male, a continuous variable indicating the sample size of male in each study; (c) sample size of female, a continuous variable indicating the sample size of female in each study; (d) what the attitude dimension that a study focused on (four categories as described above); (e) population type (three categories: "college students", "students of secondary schools", and "others", which was very ambiguous in terms of the identity of the respondents (e.g., office workers, teachers, internet-based sample, unknown due to insufficient description in a paper, etc.); (f) geographic region where the sample was from in a study in (four categories: North America, Europe, Asia, others); (g) the year when a paper was published year; (h) whether a study was a published journal article or an unpublished dissertation. Table 1 shows the coding details of these study features.

2.4. Data-analytic strategy

We followed the meta-analytic procedures recommended by Card (2012). As each study could report more than one dimensions of attitude (e.g., Affect, Belief, Self-efficacy), in order to avoid statistical dependence in the estimates, we did separate meta-analyses for different dimensions of attitude.

The standardized mean difference effect size, Hedges's *g,* was used as the common metric. The equation is expressed as ($g = (M_{male} - M_{female})/S_{pooled}$). The positive g denotes that the males had more positive attitude toward technology use than females. When the relevant descriptive statistics (e.g., group means, group standard deviations) were not directly available from a study, the conversion equation from Hedges, Shymeanshy, and Woodworth (1989) were used to obtain effect sizes from inferential statistics, such as *t*-tests, *F*-tests.

In the present study, we used the random-effects model for analyses of the effect sizes. The random-effects model does not assume that there is *one* "true" effect underlying all the studies; but rather, the "true" effects could vary depending on some study condition(s). In other words, one group of studies could have one underlying "true" effect, while another group could have a different underlying "true" effect. These different "true" effects around a general effect have an underlying distribution.

Table 1
Coding of study features.

1. Study ID: 1 to 51, representing the 51 studies used in this meta-analysis
2. Sample size of male: A continuous variable
3. Sample size of female: A continuous variable
4. Attitude Dimension
a. Affect
b. Belief
c. Self-efficacy
d. Mixed
5. Population Type
a. College
b. Secondary school
c. Others
6. Sample Region
a. Europe
b. North America
c. Asia
d. Others
7. Type of Publication
a. Journal article
b. Dissertation
8. Published year: A continuous variable

As suggested by Hedges and Vevea (1998), the random-effects model is a more reasonable choice than the fixed-effects model in general. In the random-effects model, effect sizes are weighted by the inverse of the sum of the within-study variance and between-study variance. The weighted average effect size, confidence intervals (lower and upper confidence level limits) and *z*-test results are reported and interpreted in this meta-analyses study.

The *Q*-statistics and I^2 value were also calculated for testing heterogeneity in the fixed-effects model, where the effect sizes are weighted only by the inverse of within-study variance. The I^2 is expressed as the percentage of the total variations in the effect sizes across the studies that is attributed to heterogeneity rather than the random chance. A value of 0% indicates no heterogeneity, while a large value suggests much heterogeneity (Higgins, Thompson, Deeks, & Altman, 2003). When a collection of effect sizes from individual studies is shown to be statistically heterogeneous, it is desirable to investigate the sources of such heterogeneity by conducting moderator analyses, to see if some study features (e.g., geographical areas where the sample was obtained) could have contributed to the inconsistency among the effect sizes across the studies. Testing a categorical moderator in meta-analysis involves comparing different groups of studies classified by their status on the categorical moderator. The key question when evaluating a moderator is whether there is greater-than-expected between-group heterogeneity. The statistically significant $Q_{between}$ test implies that there is statistical difference across the study feature groups (e.g., the effect sizes from the North American samples differed from those from the Asian samples). So in the present study, the subgroup analyses were also undertaken to examine whether the observed effect sizes differed significantly across the geographical areas and different samples. Finally, we also investigated the potential influence of the publication year of an article. All analyses were conducted by using the Comprehensive Meta-analysis Version 2.2.048 (Borenstein, Hedges, Higgins, & Rothstein, 2008), a widely known and widely used special statistical analysis software for meta-analysis.

3. Results and discussions

3.1. General findings

Table 2 presents some general findings, and the heterogeneity test results for the overall attitude and its dimensions across the effect sizes from individual studies. For the effect sizes collected for this meta-analysis, the average sample sizes for male and female groups are 258 and 271 respectively. But the sample sizes varied considerably across the studies, with the smallest sample sizes being 19 for male group and 7 for female group respectively, and the largest sample sizes being 2350 for both. Such a degree of variation suggests that it is necessary to weight the effect sizes of the individual studies based on sample size, because an effect size based on a small sample (e.g., 19 male, 26 female) generally would not be as stable as an effect size based on a large sample (e.g., 2350 male, 2350 female).

For the weighted effect sizes, the overall average across the 87 effect sizes was 0.17 ($p < 0.05$). Based on the general criteria in educational research, effect size of 0.2, 0.5, and 0.8 can be considered as representing a small, medium, and large effect respectively (e.g., Cohen, 1992). So the overall average effect size of 0.17 could be characterized as a statistically significant yet small effect in favor of male group (i.e., male group has more favorable attitude toward technology use). When the general attitude was broken down to different dimensions of attitude, two dimensions (Belief: 0.27, $p < 0.05$; Self-efficacy: 0.18, $p < 0.05$)) had statistically significant average effect sizes in favor of male group, while the other two (Affect: 0.10, $p > 0.05$; Mixed: 0.09, $p > 0.05$) were statistically non-significant, although still in favor of male group in terms of the direction.

The *Q* statistic for the overall attitude (1327.66, $p < 0.001$), and those for the dimensions (Affect: 591.74, $p < 0.05$; Belief: 122.79, $p < 0.05$; Self-efficacy: 420.10, $p < 0.05$; Mixed: 86.82, $p < 0.05$) were all statistically significant, indicating that the

Table 2
Weighted average effect size (random-effects model) and heterogeneity statistics (fixed-effects model) for overall attitude and for the sub-dimensions.

	Male N	Female N	*k*	*g*	95% CI Limits		Heterogeneity	
					Lower	Upper	Q-value	I^2 (%)
Overall Attitude	22502	23608	87	0.17[a]	0.09	0.25	1327.66[b]	93.52
Affect	5298	5298	21	0.10	−0.13	0.32	591.74[b]	96.62
Belief	5137	5877	22	0.27[a]	0.17	0.37	122.79[b]	82.90
Self-Efficacy	9339	9445	28	0.18[a]	0.05	0.31	420.10[b]	93.57
Mixed	2728	2988	16	0.09	−0.06	0.24	86.82[b]	82.72

k is the number of effect sizes involved.
[a] Statistically significant at $\alpha = 0.05$.
[b] Statistically significant at $\alpha = 0.001$.

effect sizes across the studies were heterogeneous. The results of I^2 for the overall attitude (0.94, $p < 0.05$), and those for the dimensions (Affect: 0.97, $p < 0.05$; Belief: 0.83, $p < 0.05$; Self-efficacy: 0.94, $p < 0.05$; Mixed: 0.83, $p < 0.05$) also indicated that about 80%–95% of the total variability could be attributed to the true heterogeneity rather than the random error. These findings warranted further exploration about potential factors, or study features, which could have contributed to the inconsistencies of the effect sizes.

To have a better understanding of the effect sizes above, we may compare the findings above with those from the previous synthesis study about twenty years ago (Whitley, 1997). It is noted that the overall gender attitudinal gap showed only minimal reduction (0.17 in this study, versus 0.23 in Whitley). For the dimensions of attitudes, for *Affect* (i.e., emotional dimension of attitude), the present study showed non-significant effect size of 0.10, in contrast to the value of 0.26 in Whitley (1997). This suggests that the gender difference on the emotional aspect of attitude has become smaller over the last two decades. For the dimension of *Belief* (i.e., cognitive dimension of attitude concerning the usefulness of technology in society), however, the value of 0.27 from the current study was obviously larger than 0.07 in Whitley (1997). On the other hand, on the dimension of Self-efficacy, the present study had the effect size of 0.18, much smaller than 0.41 from Whitley (1997), again, indicating a reduction of gender difference in the attitudes toward technology. So in general, there was only minimal reduction in the gender attitudinal gap between this study and the previous synthesis, and males still show more favorable attitudes towards technology use than females. But when the general attitude was broken down to different dimensions, with the exception of the dimension *Belief*, this study showed smaller gender difference in attitudes towards technology use than before in the dimensions of *Affect* and *Self-efficacy*.

As discussed elsewhere, such gender attitudinal differences could have been associated with multiple factors, such as females' scarce representation and participation in using technology (Ayalon, 2003), the social perception about technology users as geeks, nerds or socially isolated people, and the general view that technology was a male-dominated arena (Creamer, Lee, & Meszaros, 2006). On the other hand, some more recent social and educational developments, such as technological innovation in education (especially the integration of technology into teaching practices) and the social phenomenon that technology is becoming more ubiquitous in people' daily lives, could have created a better environment for females to embrace technology use more than before. Such social and educational environmental factors could be conducive to the reduction of the gender gap in the attitudes toward technology use. The finding that the gender gap in s*elf-efficacy* narrowed from a medium effect size of 0.41 (Whitley, 1997) to a small effect size of 0.18 in the current synthesis is especially significant and positive, because self-efficacy is generally considered to influence one's choice, effort, and persistence (Ackerman & Wolman, 2007), thus having considerable implications for gender difference in technology use.

3.2. Moderator analysis

Previous *Q* and I^2 statistics (see Table 2) suggested that the effect sizes for the gender difference in the overall attitude toward technology, and for each dimension of the attitude, was statistically heterogeneous, which led to the conclusion that there was statistical variation in the effect sizes of gender attitudinal difference towards technology across the studies. In a meta-analysis, when such effect size variation across the studies is shown, we would be interested in exploring the study features to understand what study features could have contributed to such variation. For the moderator analysis, as mentioned above, we followed the recommendation by Card (2012), and conducted separate meta-analyses for the overall attitude and for the three dimensions so as to avoid statistical dependence in the estimates. The findings for these separate analyses were summarized in Table 3, discussed below.

3.2.1. Population type

For Population Type, our focus was on student age groups (college students vs. secondary school students). It is obvious from Table 3 that, for both the overall attitude and for the three dimensions of the attitude, the gender difference in attitudes toward technology tended to be smaller among college students (0.20, 0.12, 0.31, and 0.14, for overall attitude and the three dimensions, respectively) than among the secondary school students (0.24, 0.31, 0.24, 0.24, for overall attitude and the three dimensions, respectively). These suggested that, although male students had more favorable attitudes toward technology than female students in general, such gender difference appeared to be larger among secondary school students. It is likely that, because college students were a more selected group academically (both self- and institution selection), female college students could be better prepared in terms of their knowledge and use of technology than secondary school female students. As a result, gender gap would be smaller among college students than among secondary school students.

The “Other” group showed some anomalies: −0.001 for general attitude, and −0.52 for Affect, meaning that females had more favorable attitudes toward technology. Due to the small number of effect sizes associated with the “Other” group, especially for the dimensions of attitude (e.g., $k = 3$), and due to the ambiguity of the respondents in this group, we did not explore further on this issue.

3.2.2. Sample region

The $Q_{between}$ test statistics in Table 3 indicated that the mean effect sizes of the sample regions varied statistically ($Q_{between} = 46.14, 208.50, 12.61, 90.93$, for overall attitude, and for the three dimensions respectively; all statistically significant). Although not uniformly consistent, in general, gender differences in attitudes towards technology use tended to be larger in North America samples (0.23, 0.02, 0.43, and 0.34, respectively for overall attitude, and the three dimensions), followed by Asian samples (0.12, 0.21, 0.20, and −0.01, respectively for overall attitude, and the three dimensions) and European samples (0.14, 0.15, 0.17, and 0.14, respectively for overall attitude, and the three dimensions). Following the guidelines for interpreting effect sizes ($d = 0.20$, 0.50, and 0.80 as small, medium, and large effect sizes; Cohen, 1992), These findings suggested that the gender difference in attitudes toward technology use appeared to have small to moderate effect sizes in North American samples, small effect sizes in Asian and European samples.

It is not clear what could be the possible reasons for the regional differences of gender attitudinal gap concerning technology use (i.e., samples from North America, Asia, and Europe) as described above. In general, although previous research suggested some possible regional differences related to attitudes toward technology use (see the relevant literature review presented earlier), it appears that no studies specifically examined regional differences related to *gender gap* in the attitudes toward technology use. As a result, this issue (i.e., regional variations in the gender attitudinal gap concerning technology use) did not appear to have been discussed in the research literature.

3.2.3. Publication type

In the present study, there were 68 independent samples from published journal articles, and 19 from unpublished dissertations. The effect sizes from the published journal articles (0.16, 0.07, 0.30, and 0.15, respectively for the overall attitude and the three dimensions) were in general smaller than those from the unpublished dissertations (0.21, 0.26, 0.13, and 0.34, respectively for the overall attitude and the three dimensions). It appeared that these findings would not indicate any obvious “file drawer” problem for the unpublished dissertations (i.e., more studies with statistically non-significant results were unpublished).

3.2.4. Publication year

With technology's rapid development and its ubiquitous infiltration into all aspects of our daily lives, gender difference in the attitudes toward technology use could change with time. For this purpose, we considered the possibility that the findings of research articles might show certain trend associated the publication year of a study (including unpublished dissertations). Fig. 1 present the linear regression plot for the relationship between effect size and the year of the study (both published or unpublished). It was seen that, for the time period (1997–2014), the research findings concerning gender difference effect sizes showed no obvious trend (e.g., neither increase nor decrease). The correlation coefficient for effect size and article year is, $r = -0.131$, $p = 0.227$, statistically non-significant. The comparison between the findings of this study and those from the

Table 3
Summary of moderator analysis: Weighted average effect sizes (random-effects model) for overall attitude and the three dimensions.

Moderators	Overall attitude			Dimensions								
				Affect			Belief			Self-efficacy		
	k	g	(95% CI)	k	g	(95% CI)	k	g	(95% CI)	k	g	(95% CI)
Population Type												
College	42	0.20[a]	(0.07, 0.32)	11	0.12	(−0.14, 0.37)	11	0.31[a]	(0.13, 0.49)	13	0.14	(−0.22, 0.49)
Secondary School	27	0.24[a]	(0.16, 0.33)	7	0.31[a]	(0.21, 0.40)	7	0.24[a]	(0.13, 0.39)	11	0.24[a]	(0.10, 0.38)
Others	18	−0.00	(−0.23, 0.22)	3	−0.52[a]	(−0.92, −0.12)	4	0.27	(−0.05, 0.58)	4	0.08	(−0.31, 0.46)
	$Q_{between} = 252.43$[b]			$Q_{between} = 431.74$[b]			$Q_{between} = 6.1$[a]			$Q_{between} = 2.78$		
Sample Region												
Europe	33	0.14[a]	(0.03, 0.26)	9	0.15	(−0.06, 0.36)	7	0.17[a]	(0.03, 0.32)	13	0.14	(−0.07, 0.34)
North America	34	0.23[a]	(0.06, 0.40)	8	0.02	(−0.41, 0.45)	8	0.43[a]	(−0.41, 0.45)	9	0.34[a]	(0.13, 0.55)
Asia	15	0.12[a]	(0.00, 0.23)	3	0.21	(−0.05, 0.47)	5	0.20[a]	(0.17, 0.70)	5	−0.01	(−0.27, 0.25)
Others	5	0.21[a]	(0.11, 0.32)	1	0.21	(0.11, 0.31)	2	0.23	(−0.05, 0.51)	1	0.20[a]	(0.10, 0.30)
	$Q_{between} = 46.14$[b]			$Q_{between} = 208.50$[b]			$Q_{between} = 12.61$[a]			$Q_{between} = 90.93$[b]		
Publication Type												
Journal Article	68	0.16	(0.07, 0.25)	18	0.07	(−0.17, 0.31)	18	0.30[a]	(0.19, 0.42)	24	0.15[a]	(0.01, 0.02)
Dissertation	19	0.21	(0.07, 0.35)	3	0.26	(−0.19, 0.71)	4	0.13	(−0.08, 0.42)	4	0.34	(−0.05, 0.73)
	$Q_{between} = 24.6$[b]			$Q_{between} = 23.19$[b]			$Q_{between} = 2.59$			$Q_{between} = 24.87$[b]		

[a] Statistically significant at $\alpha = 0.05$.
[b] Statistically significant at $\alpha = 0.001$.

previous synthesis study (i.e., Whitley, 1997) also didn't indicate a meaningful reduction of gender differences in attitudes toward technology. These findings suggested that the gender attitudinal gap in technology use did not appear to be related to time.

4. Conclusions

This meta-analysis study quantitatively summarized prior empirical studies on gender differences in attitudes toward technology use over about seventeen years. Several findings stood out. First, in general, males showed more favorable attitude toward technology use than females, especially on the dimensions of *belief* (e.g., believing in the societal usefulness of technology) and *self-efficacy* (e.g., self-confidence in one's ability to learn and use technology effectively). These findings indicated that, in general, women showed lower level of attitude toward technology use than their male counterparts, and these findings were confirmed by many recent studies (Ardies et al., 2015; Ong & Lai, 2006; Sáinz & López-Sáez, 2010; Yau & Cheng, 2012). However, it should be pointed out that, although women may have shown slightly lower levels of attitudes than men, their attitudes toward technology use were still positive, not negative.

However, compared with previous meta-analysis studies, in general, the gender attitudinal gap showed very small reduction. But there was a noticeable reduction in gender gap with regard to *self-efficacy*, which is regarded as an important attitudinal dimension with implications for a person's choice, effort, and persistence.

Also noticeable is the comparison between studies involving college student samples and those involving secondary school student samples. Some earlier studies indicated that age was related to gender difference in attitude toward technology use (e.g., Harrison & Rainer, 1992). Most individual studies, however, did not provide sufficient information about age of the participants; instead, the information about school categories (e.g., secondary school, university level) was available in many. For this practical reason, we focused on the comparison between secondary school and college level students. The findings indicated that secondary school students showed large gender attitudinal gap with regard to technology use than college students in general. This makes intuitive sense, as college students are a more selected group academically (either through self-selection, or through institutional selection); female students in this selective group could be more prepared for technology use and they could have higher level of technology competency than general female population; as a result, their attitude toward technology use could be more positive.

The reasons for the finding concerning differences across samples from different regions (i.e., samples from North America, Asia, Europe) were unclear, and it is possible that some societal and cultural norms and factors could been playing a role in influencing gender groups' attitude toward technology use. This issue should receive more attention in future research. The comparison between published journal articles and the unpublished dissertations showed, in general, larger effect sizes from the unpublished dissertations than those from the published journal articles. This finding did not suggest the existence

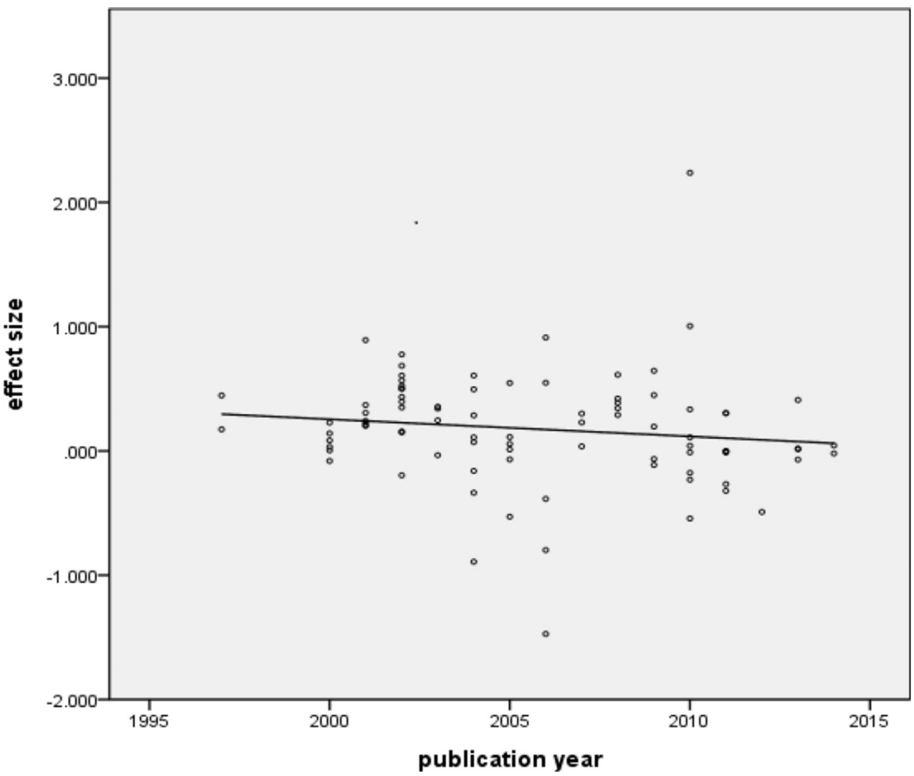

Fig. 1. Relationship between effect size and publication year.

of the "file drawer" problem associated with unpublished studies. Across the time frame examined (1997–2014), no statistical relationship was found between gender gap effect sizes and time, indicating that there was no systematic trend of change of gender attitudinal gap with this given time period.

In short, this synthesis provided evidence that females still have less positive attitude toward technology use in general, despite the rapid development of technology in the past two decades, and despite the increasing ubiquity of technology in our lives. Different levels of attitudes toward technology use could entail different behavior, and ultimately, lead to differential uses of technology (Volman, van Eck, Heemskerk, & Kuiper, 2005). Such gender attitudinal gap could be the result of multiple factors, including the general conceptions that technology is a male-dominated arena, that males are more competent users of technology, and other social and cultural norms and factors. Understanding the gender attitudinal difference toward technology use should help us consider policies and educational opportunities to counteract against any unfavorable cultural or social preconceptions about technology, which could explicitly or implicitly hinder females', especially younger girls', learning and using technology, thus helping females in their development of technology use.

5. Limitations and future directions

This synthesis study has some weaknesses, and also points to some future research directions. Although some differences across geographical regions were observed, it is unclear how such findings could be explained, due to a lack of understanding about possible social and cultural norms and factors that could influence gender groups' attitude toward technology use in different cultural/societal contexts. This issue should be further explored in future research.

The relationship between age and gender attitudinal gap toward technology should be an important issue for understanding the trend of such gender attitudinal gap as related to age (e.g., Does such gap start at young age? Does such gap become larger or smaller with age?). Such information could be very helpful for formulating supportive policies and opportunities targeting females at optimal age range in order to support their development of technology use, and encourage them to more actively consider technology as career choices. The individual studies used for this synthesis did not allow us to make a more refined analysis concerning gender attitudinal gap toward technology and age, and we were only able to consider groupings of secondary school students and college students. Future research may focus more on the issue of age as related to the gender attitudinal gap toward technology use.

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Appendix

Individual studies included in the meta-analysis.

Study ID	N_male	N_female	attitude type	population type	sample country	publication type	Effect size (g)
Ahmad, 2000	55	193	affect	teachers	USA	D	−0.163
Ahmad, 2000	55	193	affect	teachers	USA	D	0.001
Ahmad, 2000	55	193	belief	teachers	USA	D	0.032
Ahmad, 2000	55	193	self-efficacy	teachers	USA	D	0.142
Ahmad, 2000	55	193	mixed	teachers	USA	D	0.005
Al-kamali, 2007	115	89	mixed	secondary school	Northwest Arkansas	D	0.038
Alzamil, 2003	99	84	mixed	teachers	Saudi Arabia	D	−0.034
Baloğlu & Çevik, 2008	389	326	affect	secondary school	Turkey	J	0.344
Bråten & Strømsø, 2006	29	51	affect	college	Norway	J	−0.798
Brosnan & Lee, 1998	101	95	mixed	college	UK	J	0.446
Brosnan & Lee, 1998	125	126	mixed	college	HK	J	0.174
Chen and Tsai, 2007	940	926	belief	college	Taiwan	J	0.23
Chou et al, 2011	530	531	belief	college	Taiwan	J	0.109
Colley & Comber, 2003	522	417	affect	secondary school	UK	J	0.342
Colley & Comber, 2003	522	417	self-efficacy	secondary school	UK	J	0.357
Collis and Williams, 2001	958	760	affect	secondary school	Canada and China	J	0.209
Collis and Williams, 2001	958	760	belief	secondary school	Canada and China	J	0.37
Collis and Williams, 2001	958	760	self-efficacy	secondary school	Canada and China	J	0.201
Comber, Colley, Hargreaves, & Dorn, 2006	147	131	affect	secondary school	Leicestershire	J	0.548
Comber et al, 2006	147	131	self-efficacy	secondary school	Leicestershire	J	0.913
Cuadrado-García, Ruiz-Molinaa, & Montoro-Ponsb, 2010	19	26	affect	college	Spain	J	−0.232
Cuadrado-García et al, 2010	19	26	belief	college	Spain	J	−0.176
Cuadrado-García et al, 2010	19	26	self-efficacy	college	Spain	J	−0.543
Durndell et al, 2000	220	128	self-efficacy	college	East European	J	0.229

(*continued*)

Study ID	N_male	N_female	attitude type	population type	sample country	publication type	Effect size (g)
Durndell & Haag, 2002	76	74	affect	college	East European	J	0.35
Durndell & Haag, 2002	76	74	belief	college	East European	J	0.499
Durndell & Haag, 2002	76	74	self-efficacy	college	East European	J	0.566
Fleming, 2005	136	222	belief	college	USA	D	0.058
Hasan, 2010	44	36	affect	college	USA	J	1.004
Hasan, 2010	44	36	belief	college	USA	J	2.238
Lu & Chiou, 2010	353	169	affect	college	TaiWan	J	0.45
Huneke, 2002	145	207	affect	college	USA	D	0.686
Huneke, 2002	145	207	belief	college	USA	D	0.397
Huneke, 2002	145	207	self-efficacy	college	USA	D	0.776
Imhof et al., 2007	24	23	self-efficacy	college	Germany	J	0.301
Jackson et al., 2001	227	403	affect	college	USA	J	0.23
Jackson et al., 2001	227	403	belief	college	USA	J	0.242
Jackson et al., 2001	227	403	self-efficacy	college	USA	J	0.307
Johnson, 2011	303	252	affect	college	USA	J	−0.266
Njagi, 2003	88	38	mixed	college	USA	D	0.246
Karr, 2014	85	351	mixed	teachers	USA	D	0.045
Kay, 2009	327	327	belief	secondary school	Canada	J	0.388
Kay, 2009	327	327	self-efficacy	secondary school	Canada	J	0.613
Kesici et al., 2009	97	166	mixed	college	Turkey	J	0.195
Madu et al., 2011	44	44	mixed	college	Nasarawa	J	0
Martin, 2009	65	55	belief	employee	USA	D	−0.064
Martin, 2009	65	55	self-efficacy	employee	USA	D	−0.113
Mayall, 2002	96	92	self-efficacy	secondary school	USA	D	0.501
Mckendrick, 2001	55	7	mixed	teachers	USA	D	0.892
McKinley, 2014	46	57	mixed	volunteer respondents	USA	D	−0.021
Morris, 2002	184	117	affect	college	USA	D	0.149
Morris, 2002	115	181	mixed	college	USA	D	0.525
Nistor, 2013	47	109	mixed	college	Germany	J	−0.069
North & Noyes, 2002	52	52	belief	secondary school	England	J	0.158
North & Noyes, 2002	52	52	mixed	secondary school	England	J	−0.196
Ong & Lai, 2006	89	67	belief	employee	Taiwan	J	0.495
Ong & Lai, 2006	89	67	self-efficacy	employee	Taiwan	J	0.607
Price, 2006	98	111	affect	college	UK	J	−0.387
Price, 2006	98	111	self-efficacy	college	UK	J	−1.472
Sáinz & López-Sáez, 2010	252	298	affect	secondary school	Spain	J	0.335
Sáinz & López-Sáez, 2010	252	298	belief	secondary school	Spain	J	0.042
Saleem, Beaudry, & Croteau, 2011	66	77	self-efficacy	library system users	Canada	J	−0.32
Sam et al., 2005	67	80	affect	college	Malaysia	J	0.013
Sam et al., 2005	67	81	belief	college	Malaysia	J	−0.068
Sam et al., 2005	67	81	self-efficacy	college	Malaysia	J	0.112
Schottenbauer et al., 2004	802	698	affect	internet-based sample	USA	J	−0.892
Schottenbauer et al., 2004	802	698	mixed	internet-based sample	USA	J	0.07
Schottenbauer et al., 2004	802	698	mixed	internet-based sample	USA	J	−0.337
Sieverding & Koch, 2009	49	53	self-efficacy	college	Germany	J	0.645
Sieverding & Koch, 2009	50	54	self-efficacy	college	Germany	J	0.642
Terzis & Economides, 2011	56	117	belief	college	Greece	J	0.305
Terzis & Economides, 2011	56	117	self-efficacy	college	Greece	J	0.304
Tomte & Hatlevik, 2011	2350	2350	self-efficacy	secondary school	Finland	J	−0.013
Tomte & Hatlevik, 2011	2350	2350	self-efficacy	secondary school	Norway	J	−0.002
Torkzadeh & Van Dyke, 2002	78	111	self-efficacy	college	USA	J	0.606
Torkzadeh & Van Dyke, 2002	78	111	self-efficacy	college	USA	J	0.434
Tsai & Lin, 2004	327	309	affect	secondary school	Taiwan	J	0.11
Tsai & Lin, 2004	327	309	belief	secondary school	Taiwan	J	0.287
Tsai & Lin, 2004	327	309	self-efficacy	secondary school	Taiwan	J	−0.16
Tsai & Tsai, 2010	450	460	self-efficacy	secondary school	Taiwan	J	−0.011
Vekiri & Chronaki, 2008	174	166	belief	secondary school	Greece	J	0.29
Vekiri & Chronaki, 2008	174	166	self-efficacy	secondary school	Greece	J	0.421
Vekiri, 2013	117	144	affect	secondary school	Greece	J	0.411
Vekiri, 2013	117	144	belief	secondary school	Greece	J	0.013
Vekiri, 2013	117	144	self-efficacy	secondary school	Greece	J	0.02
Weiser, 2000	297	387	belief	college	world wide	J	0.085
Yau & Cheng, 2012	109	102	self-efficacy	college	Hong Kong	J	−0.491
Zhang, 2005	184	496	affect	internet survey	USA	J	−0.529
Zhang, 2005	184	496	belief	internet survey	USA	J	0.546

J = Journal Article, D = Dissertation.

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[1] (An asterisk indicates that the study was used in the meta-analysis).

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