RESEARCH REPORT

THE PLURALISM OF WORLDVIEWS IN MIXED METHODS RESEARCH: WHERE DO I STAND?

Authors

- Pierre Pluye, pierre.pluye@mcgill.ca, Department of Family Medicine, McGill University, Canada
- Reem El Sherif, reem.elsherif@mail.mcgill.ca, Department of Family Medicine, McGill University, Canada
- Quan Nha Hong, quan.nha.hong@mcgill.ca, Department of Family Medicine, McGill University, Canada
- Isabelle Vedel, isabelle.vedel@mcgill.ca, Department of Family Medicine, McGill University, Canada

Cite as: Pluye, P., El Sherif, R., Hong, Q. N., & Vedel, I. The pluralism of worldviews in mixed methods research: Where do I stand? *McGill Family Medicine Studies Online, 2021, 16: e03.*

INTRODUCTION

In this research report, we review the literature on the pluralism of scientific worldviews in Mixed Methods (MM) research. This report is a companion of a textbook chapter that proposes a conceptual framework and a practical aid for combining worldviews, when needed and desirable (Pluye, Hong, El Sherif, & Vedel, in press). The *Framework and Aid for Combining Worldview* differentiates six possible combinations of worldviews: three with integration of worldviews (multiple worldviews, complementary strengths, and dialectical pluralism) and three without integration (a-paradigmatic, substantive theory, and single worldview). The aid is comprised of a decision tree for graduate students and novice researchers; it provides recommendations for selecting an appropriate combination of worldviews.

In this report and companion chapter, we define worldviews as personal sets of philosophical assumptions or beliefs that guide actions. In contrast to the community-level concept of paradigm, which reflects the shared commitment of a community of scientists to a set of logics, models and exemplars (Hacking, 1981; Kuhn, 1983), we use the individual-level term worldview to indicate that the focus is on a person's view of the world and the sciences, which usually mirrors paradigm(s). As stated by Denzin (2010), "paradigms are human constructions, and define the shifting worldview of the researcher-as-bricoleur" (p. 421). When working in MM teams, each researcher's worldview reflects their preferred paradigm (consciously or unconsciously).

In our 15-year experience of teaching MM, we found that graduate students and novice researchers can be puzzled over scientific worldviews. MM is an opportunity to force and cast new light on the use of researchers' differing worldviews, but this comes with several challenges. Indeed, philosophical points of view and worldviews are often muted in MM publications because researchers and students choose to integrate qualitative (QUAL) and quantitative (QUAN) methods, but not paradigms, for many defensible reasons, e.g., to avoid worldview-related tensions between MM research team members. Hereafter, QUAL and QUAN methods refer to research question/objective, design, data collection/analysis and results, regardless of scientific paradigms and worldviews.

The purpose of this report is to help graduate students and novice researchers find or confirm where they stand. The specific objectives of the present research report are fourfold: (a) identify reference texts on worldviews in MM; (b) define two extreme worldviews incompatible with MM; (c) determine the characteristics of the most common worldviews compatible with MM; and (d) describe the frequency of the use of these worldviews and their combinations in MM empirical studies.

BACKGROUND

MM integrates QUAL and QUAN methods in program evaluation, primary research and literature reviews (Baškarada & Koronios, 2018; Creswell & Plano Clark, 2018; Greene, 2007; Johnson, Onewuegbuzie, & Turner, 2007; Pluye & Hong, 2014; Pluye, Hong, Bush, & Vedel, 2016; Pluye, Kaur, Granikov, Garcia Bengoechea, & Tang, 2018; Tashakkori & Teddlie, 2010; Teddlie & Tashakkori, 2009). Typically, QUAL and QUAN methods can be integrated at five levels : (a) the MM team members' worldviews and methodologies, (b) the research questions and specific objectives, (c) the literature review, (d) the MM design, be it sequential, convergent, multiphase, multilevel, or multiphase-multilevel, and (e) the data collection and analysis (Pluye et al., 2018).

Our report contributes to knowledge on the first level of integration by focussing on five common contemporary worldviews in MM research. It assumes the pluralism of worldviews in MM. About 15 years ago, Teddlie and Tashakkori (2003) claimed the coexistence of different worldviews in MM. This pluralism has been confirmed in other publications (Ghiara, 2019; Niglas, 2010). This pluralism may be underreported for at least three reasons. First, the scientific paradigms and researchers' worldviews may not be seen worth of publication (Coates, 2021; Greene, 2007). By way of illustration, in a sample of 66 MM behavioral and social studies publications from 2005, Alise and Teddlie (2010) found worldview-related sentences in only one article (1.5%). This does not necessarily mean the issue was ignored; it could simply mean that other things were more critical to include within the allotted word limit. Second, some researchers may not be conscious of the influence of their worldview on their research (or minimize this influence compared to other elements such as theories). Third, others may be

unsure about their personal worldviews as one's worldview can evolve over time, especially during one's doctoral training (Baumard, 1997), and silence their uncertainties.

In this report, one's worldview does not equate to one's choice of QUAL or QUAN or mixed methods; worldviews can influence methods, but they do not determine them. As stated by Greene (2007) and Maxwell and Mittapalli (2010), a method is not associated with a single paradigm or worldview, and any method can be informed by one or more than one paradigm or worldview. We will begin with two extreme worldviews (Delanty & Strydom, 2003) that are deemed incompatible with MM research according to most MM scholars: historical positivism (usually associated with QUAN methods) and radical constructivism (usually associated with QUAL methods). We view the discussion of these extremes as an essential pedagogical material to better understand the five common worldviews that are compatible with MM research: postpositivism, social constructivism, pragmatism, critical theory, and critical realism. We limited this review to the five most common worldviews in MM because we did not perform an exhaustive review of paradigms and worldviews in MM research (out of scope of this research report).

METHODS

A 2-phase literature review was conducted using reference texts, i.e., textbooks and reference articles on worldviews in MM research (phase-one), and empirical MM papers (phase-two).

Phase one: In order to define the characteristics of each worldview, the first phase was a review of worldview-related MM reference texts selected from three sources. In March 2018, the first author (PP) identified textbooks with MM in the title from an online book seller (Amazon.ca). He selected 14 textbooks from the first 10 webpages, i.e., books including a chapter on worldviews in MM. Saturation was achieved after seven webpages (no new textbook, only previous editions). Then, also in March 2018, he identified English and French reference articles in the bibliographic database Scopus using the following search string with no date or discipline restrictions: TITLE ("mixed method*") AND TITLE-ABS-KEY ("worldview*" OR "paradigm*" OR "epistemolog*" OR "philosoph*"). He selected 34 articles that focus on philosophical reflections. Finally, he selected an additional four articles focussing on worldviews in MM from his personal files.

Using word-processor and graphic software, two authors (PP and QNH) extracted worldview related text (key quotes), and tables comparing worldviews, from the included books and articles. They assigned worldviews (such as postpositivism, social constructivism, pragmatism, critical theory, and critical realism) to text and tables, which constituted the data. For each worldview, PP interpreted and coded the data according to four characteristics: ontology, epistemology, research purpose, and methodology (Gendron, 2001; Ridde & Dagenais, 2012). Ontology refers to 'what is researched' (the nature of things). Epistemology refers to 'how researchers know what they know' (the origin of knowledge). The Research Purpose addresses 'why research is done',

e.g., the goal of a MM study. Methodology is the 'strategic when, where, how and by/with whom research methods are performed'. Then, PP assessed the frequency of each worldview in the selected reference texts and developed a comparative table of the five worldviews and their characteristics in terms of ontology, epistemology, research purpose, and methodology.

Phase-two: In order to determine the frequency of use of worlviews in MM studies, two authors (PP and RES) examined a sample of full-text papers reporting MM empirical studies in the authors' research area, i.e. patient-oriented research in health and social sciences. They searched within an existing dataset of MM papers (Pluye et al., 2018), which were indexed in Scopus in 2015, had 'mixed methods' in the title, and provided a detailed description of the QUAL, QUAN and MM components. They included only papers that contained at least one worldview-related sentence. In order to do so, PP and RES retrieved sentences with any words including the following chains of letters: 'epistemolog', 'paradigm', 'worldview', 'constructivis', 'positivis', 'realis', 'theor', and 'pragmat'. They extracted worldview-related sentences from each included paper together with their abstracts and paragraphs (i.e., the data) describing these aspects of the MM study. Then, they assigned a worldview to each extracted paragraph, tabulated findings, and determined the frequency of the reporting of worldviews and their combinations.

RESULTS

Reference texts on worldviews in MM research

With regard to the first objective, we identified 52 reference texts on worldviews in MM research, i.e., 14 textbooks and 38 reference articles. For each worldview, we summarized these texts in comparative tables to help graduate students and novice researchers understand and retain the characteristics of the worldviews. Table 1 shows the distribution of worldviews across the included 52 MM reference texts. The synthesis of these texts included two extreme worldviews and five contemporary common worldviews that we describe herein.

Table 1. Included MM reference texts addressing worldviews

Worldviews defined in the publication	Textbooks (n=14)	Reference articles (n=38)
• *Constructivism or social constructivism	11	8
• *Positivism or postpositivism	8	10
• Pragmatism	13	23
• Critical theory (action research, feminism, transformativism, etc.)	9	17
• Critical realism	6	7
• Other: anticonflationism (n=1), functionalism (n=1), humanism (n=1), and postmodernism (n=4)	4	3

**Some included reference texts did not make a clear distinction between historical positivism and postpositivism, and between radical constructivism and social constructivism. This confusion led us to lump positivism and postpositivism into one category, and constructivism and social constructivism into another category.*

Two extreme worldviews incompatible with MM research

Regarding our second objective, we defined two extreme worldviews deemed incompatible with MM research and incommensurable with any other worldview, i.e., historical positivism and radical constructivism (Table 2). According to Fetters (2020), it is not possible for researchers who espouse one of these worldviews to carry out MM research. However, we think that knowing what is not compatible with MM is essential to help graduate students and novice researchers to learn what is compatible (similar to how learning differential diagnosis in clinical apprenticeship helps health students to identify one or a few of the most possible diagnoses). Stated otherwise, this section and Table 2 illustrate two worldviews that are deemed incompatible with MM research, like differential diagnoses. Specifically, the comparative table 2 synthesizes the descriptions of these two worldviews derived from the reference texts, one textbook on philosophy of sciences (Delanty & Strydom, 2003) and widely cited scholars on these worldviews.

First, historical positivism combines naive realism and pure objectivism to confirm truth in a deductive manner, for the most part. Among the 52 included MM textbooks and reference articles, only eight compared more than two scientific paradigms or worldviews including three comparing historical positivism (also referred to as positivism) to postpositivism (Azzopardi & Nash, 2014; Ma, 2012; Teddlie & Tashakkori, 2009). Maxwell and Mittapalli (2010) referred to historical positivism's naïve realism in education research, and this label was used by the three MM scholars who contrasted positivism and postpositivism (Azzopardi & Nash, 2014; Ma, 2012; Teddlie & Tashakkori, 2009). Historical positivism was founded by Auguste Comte who proposed and spread the 'positive philosophy' in 1850s in France (Delanty & Strydom, 2003). Comte promoted positivism for natural and social sciences, and fostered universalism. In contrast to Descartes' rationalism and theology, Comte (2003) stated that positivism seeks to continuously improve and organize life (human progress), while reality (positivity) is defined in all domains by natural laws (absolute certitude), logical deduction and objective rationality (precision). He applied positivity to human actions and ideas as well as the environment (external objects). Positivism rapidly influenced experimental medicine (Bernard, 1966), among other disciplines. In the 1930s, it was radicalized by the academic members of the 'Vienna Circle', while at the same time being challenged by logical positivists. Following World War II, it was replaced by postpositivism (Delanty & Strydom, 2003, pp. 13-16). Today, numerous scholars argue that historical positivism is at best a debunked dogma that is not compatible with science; thus, incompatible with MM. However, Park, Konge, and Artino (2020, p. 690) recently provided "examples of positivist research in health professions education" such as a case study of how a supervisor working with the positivist paradigm can approach a resident caring for a patient following a surgical operation. Thus, one can argue that, still today, historical positivism may influence certain researchers, and is a straw man sometimes used to stereotype the philosophy of QUAN methods, and for "self-proclaimed quantiphobes" to stigmatize all types of quantification and statistics (Boyatzis, 1998, p. viii).

Second, radical constructivism combines naive relativism and pure subjectivism to explore new ideas in an inductive manner, for the most part. None of the eight reference texts that compared more than two scientific paradigms or worldviews, compared radical constructivism and social constructivism. They all mix cognitive/radical constructivism and social constructivism in a category labelled as constructivism or constructivism/interpretativism (Azzopardi & Nash, 2014; Christ, 2013; Creswell & Plano Clark, 2018; Ma, 2012; Mertens, 2017; Plano Clark & Ivankova, 2015; Shannon-Baker, 2016; Teddlie & Tashakkori, 2009). However, constructivism can be seen as a collection of at least six variants: constructionism, constructivism, micro-constructionism, macro-constructionism, radical constructionism, and moderate constructionism (Rees, Crampton, & Monrouxe, 2020). This highlights a contribution of this report to the long-standing conversation on worldviews in MM research (the contrast between radical constructivism and social constructivism). Delanty and Strydom (2003) and Maxwell and Mittapalli (2010) oppose radical constructivism to social constructivism. Radical constructivism is derived from the 1920s comprehensive approaches proposed by various scholars such as Max Weber in Germany (Weber, 1992) and Gaston Bachelard in France. For example, Bachelard (1999) criticized Comte's naive realism and pure deduction. He stated that "scientific evidence is affirmed in the life experience [in contact with constructed reality] and reasoning" (p. 7), and that "true scientific reasoning is inductive (…)" because laws are derived from facts, and "rules from examples" (p. 10). According to Bachelard (1999), science objectifies reality via research methods and instruments; but ultimately, everything is theory, including measurement (idealism). He argued that researchers' subjectivity must be taken into account given its potential to be misleading (value-based induction). In his book on teaching science, Bachelard (1993, p. 241) stated that researchers' subjectivity can be limited by maintaining the focus on the perceptions of others: "tell me what you see, and I will tell you what it is" (subjectivism). In line with his worldview, evidence is always contextual (relativism), specifically in mathematics and physics. He wrote three famous sentences on his constructivist worldview: "Nothing is self-evident. Nothing is given. All is constructed." (Bachelard, 1993, p. 14). Then, Piaget (1964, 1970) promoted psycho-constructivism based on his work on child development (children construct the world in constructing themselves). Later, Von Glasersfeld (2001) coined the term 'radical constructivism': similar to children, students and researchers also construct their own representations of reality using their subjective experiences (Jonnaert & Masciotra, 2004), and "nothing exists outside of discourse" (idealism), thereby denying any material foundation of life experience (Rees et al., 2020, p. 848). This kind of constructivism can also be labelled "cognitivist" and "is called 'radical' because it seeks to bring ontological argumentation back to the source of the argument in a self-referential or reflexive way" (Delanty & Strydom, 2003, p. 374). Radical constructivism is nowadays somewhat limited to the mathematics in education, but it is a straw man sometimes used to stereotype the philosophy of QUAL methods, and for "self-proclaimed qualiphobes" to stigmatize all types of interpretation of data and qualitative research (Boyatzis, 1998, p. viii).

Table 2. Two extreme scientific worldviews incompatible with mixed methods research

WORLDVIEWS	ONTOLOGY The nature of things: realism vs. relativism	EPISTEMOLOGY The origin of knowledge: objectivism vs. subjectivism	RESEARCH PURPOSE Confirm vs. Explore	METHODOLOGY Deduction vs. induction
Historical positivism	*Naive realism* There is only one true reality. Researchers look for an objective external reality based on omnipotent natural laws. Everybody can agree on true or false hypotheses. All reality is physical (physicalism).	*Pure objectivism* Knowledge is physically independent from researchers. There is a truth for everything, i.e. a true universal and scientific knowledge (foundationalism).	*Mainly to confirm truth* Natural laws allow researchers to physically replicate studies. Sometime to discover laws: new natural laws allow researchers to build physical reality (nomothetic), e.g., causal relations.	*Deduction** Research design, data collection and analysis, and results are mainly hypothetico-deductive and unbiased. Researchers are impartial and objective (value-free inquiry); but they sometimes speculate about new hypotheses and test them (law discovery).
Radical constructivism	*Naive relativism* Everybody constructs their 'world' (individual relativism), including researchers. The world and sciences are subjective. Multiple internal personal realities exist (in people's minds). All reality exists in ideas (idealism).	*Pure subjectivism* Knowledge is based on individual subjective points of view, including those of researchers.	*Mainly to explore new ideas* Researchers start with participants' subjective ideas, and they develop conceptual patterns and theoretical models (monistic). This allows researchers to describe and better understand phenomena under study, e.g., explore points of view, life experiences and meanings of actions or events.	*Induction*** Research designs are interpretive. Researchers subjectively collect and interpret subjective data in an inductive manner. They create findings (emergent findings). There is no right or wrong value (only different values).

**In three MM reference texts with comparative tables including positivism, the methodology is associated with QUAN methods (Azzopardi & Nash, 2014; Ma, 2012; Teddlie & Tashakkori, 2009).*

***In three MM reference texts with comparative tables including constructivism (mixing cognitive/radical and social constructivism), the methodology is associated with QUAL methods (Azzopardi & Nash, 2014; Mertens, 2017; Teddlie & Tashakkori, 2009).*

Characteristics of the five most common contemporary worldviews in MM

With regard to the third objective, we determined the characteristics of five worldviews compatible with MM: postpositivism, social constructivism, pragmatism, critical realism, and critical theory. Those are the five most common contemporary scientific worldviews in MM. In other words, a combination of these compatible worldviews can be routinely used in QUAL, QUAN and MM studies when a research team includes researchers whose worldviews differ. As shown in Table 1, 49 of 52 included reference texts define at least one of these worldviews. In accordance with Maxwell and Mittapalli (2010, p. 151), these are alternatives to both the "naive realism" of historical positivism, and "radical constructivist views that deny the existence of any reality apart from our [mental] constructions". We claim that in the pandemonium of worldviews,

the following five common worldviews, and most importantly their combinations, can encourage graduate students and novice researchers to grasp nuances that differentiate MM team members' worldviews, identify the combinations of worldviews at stake in their MM project, and eventually reconcile them when needed (see companion chapter).

In Table 3, the characteristics of the five most common worldviews in MM are displayed. Of those, four correspond to the main categories of scientific worldviews described in philosophical and social science works by Delanty and Strydom (2003): postpositivism (after the dissolution of positivism), constructivism (in line with the interpretive tradition), the critical tradition, and pragmatism. Of the five common worldviews, three correspond to "emerging contemporary paradigms" in MM according to Greene (2007, p. 69): pragmatism, critical theory, and critical realism. Similar to Table 2, the comparative Table 3 does not coin new terms in the field of MM, whereas some terms might be non-standard in philosophy of sciences because most MM scholars and researchers/teachers are not philosophers or sociologists of sciences (like us).

The comparative Table 3 is to facilitate graduate students' and novice researchers' reading and retention of the distinct characteristics of the five most common worldviews compatible with MM research. Of the 52 included MM textbooks and reference articles, only eight compared more than two scientific paradigms or worldviews in table format (Azzopardi & Nash, 2014; Christ, 2013; Creswell & Plano Clark, 2018; Ma, 2012; Mertens, 2017; Plano Clark & Ivankova, 2015; Shannon-Baker, 2016; Teddlie & Tashakkori, 2009). Of these eight tables, critical theory (referred to as advocacy-participatory, transformative-action, transformative-emancipation, and transformative) was described in all of them, postpositivism, constructivism, and pragmatism were each described in seven, and critical realism was described in three tables. In the Appendix 1, the Table 3 has been summarized in a 1-page hand out that is given to participants of the FMED 608 (Advanced Mixed Methods) annual 1-credit course on scientific worldviews in MM research (Department of Family Medicine, McGill University).

Table 3 synthesizes descriptions of common worldviews derived from these eight tables, one textbook on the philosophy of science (Delanty & Strydom, 2003), a series of philosophical articles recently published in the Academic Medicine, a top tier journal (Ellaway, Kehoe, & Illing, 2020; Paradis, Nimmon, Wondimagegn, & Whitehead, 2019; Rees et al., 2020; Young & Ryan, 2020), and widely cited scholars on these worldviews: postpositivism (Campbell, 1988; Overman, 1988), social constructivism (Hacking, 1999), pragmatism (De Waal, 2005), critical theory (Tyson, 2014), and critical realism (Sayer, 2000). In contrast to the clear-cut opposition between historical positivism and radical constructivism, the following five contemporary common worldviews may appear to overlap somewhat; yet, they are distinct.

Table 3. Five common contemporary scientific worldviews compatible with mixed methods research

WORLDVIEW	ONTOLOGY	EPISTEMOLOGY	RESEARCH PURPOSE	METHODOLOGY
Postpositivism	*Evolutionary realism:* Reality understood only imperfectly. Continuous improvement of this understanding based on an iterative selection of most plausible rival hypotheses.	*Truthful scientific knowledge (but no truth):* Dualism between a certain objectivity of sciences (e.g., objective world) and the research stakeholders' subjectivity (subjective reviewers, researchers and participants).	*Mainly to confirm hypotheses* and generalize results of previous work (e.g., replicate empirical studies), but sometimes to explore new ideas (e.g., discover new scientific theories).	*Mainly hypothetico-deductive* (e.g., test of hypotheses), but potentially inductive (e.g., development of new hypotheses). Biased data collection and analysis, e.g., influenced by researchers' values (influences at least partially controllable).
Social constructivism	*Ontological relativism:* Multiple constructed intersubjective realities (limited to human, e.g., people classified, and indifferent kinds, e.g., classifications).	*Intersubjective knowledge:* Dualism between the intersubjective continuous social construction of human and indifferent kinds (processing individual subjective views), and a certain objectivity limited to natural kinds, e.g., rocks.	*Mainly to explore new ideas* (e.g., discover new scientific theories), but sometimes to confirm patterns and/or theories from previous work (e.g., transfer theories in other contexts).	*Mainly inductive* (e.g., development of patterns and/or theories), but potentially deductive (e.g., improvement of patterns and/or theories). Interpretation of data influenced by researchers' and participants' values.
Pragmatism	*Action-related views of reality (what works)*: Singular (individual) and multiple (social) views of realities. Best explanations determined by personal values regarding the action understudy.	*Action-based knowledge*: Dualism between (a) objective and subjective views depending on the stage of the research process, and (b) the insiders' knowledge (e.g., participants) and the external observers' knowledge (e.g., researchers).	*To explore and/or confirm action-oriented* practical solutions and meaning-making (valued in action by research stakeholders such as the decision/policy makers, the practitioners, the public, and the researchers).	*Action-centered inductive and/or deductive* data collection, analysis and solutions (what works): Use of most relevant methodologies and methods to address the action-centered questions and/or objectives.
Critical theory	*Promotion of social justice via scientific understanding and explanations*: Diverse views regarding realities based on different cultural, economical, political and social positions or power issues. Findings negotiated with participants.	*Representation of the voice and views of the oppressed*: Both objectivity and interaction with participants valued by researchers. Collaboration and knowledge sharing with participants based on their experiences of their realities.	*To explore and/or confirm and reduce inequities* (e.g., cultural and social): To enact individual empowerment and social changes for marginalized groups for instance.	*Inductive and/or deductive participatory research methodologies and methods* (e.g., participants involved at all stages of the research process including method-related decision-making). Improvement of individual well-being and social justice. Research influenced by participants' values ('right' values versus other values - 'wrong' values -).

Critical realism	*Ontological realism*: Reality independent of human understanding. Reality understood using meaning-making processes based on an a priori or an emerging *MRT (linking contextual influences to outcomes via psycho-social mechanisms).	*Epistemological relativism:* *MRT-based researchers' subjectivity. Impossible objectivity about social phenomena (scientific knowledge about reality being constructed from a researchers' view, i.e., the MRT).	*Mainly to confirm and/or test an a priori *MRT* (e.g., in different settings), but sometimes to explore new ideas for building a new emerging MRT or improving an a priori MRT (e.g., discover new mechanisms and outcomes under different contextual influences).	**MRT-driven deduction, induction, abduction, and retroduction*: MRT-driven collection/analysis of data and interpretation of results valued by researchers combining a data-based MRT-driven deduction and induction, with abduction (MRT-driven interpretation of phenomena) and retroduction (MRT-driven reconstruction of phenomena's conditions) when data are missing.

**MRT: Middle Range Theory. "MRT is an implicit or explicit explanatory [process] theory that can be used to assess programs and interventions. "Middle-range" means that it can be tested with the observable data and is not abstract to the point of addressing larger social or cultural forces (i.e., grand theories)" (Jagosh et al., 2012, p. 316).*

Postpositivism

Our definition of postpositivism is, for the most part, in accordance with that of Donald T. Campbell, an American psycho-sociologist, renowned for the classification of quasi-experimental designs in the 1960s (among other contributions) who gave his name for the international Campbell Collaboration network in social sciences (Azzopardi & Nash, 2014; Campbell, 1988; Christ, 2013; Giddings & Grant, 2007; Ma, 2012; Overman, 1988; Phillips & Burbules, 2000; Shadish, Cook, & Campbell, 2002). Among French-speaking scholars, Granger (1995) is a leading representative of this worldview, and we use his work to illustrate the definition of postpositivism.

ONTOLOGY - Evolutionary realism: The researchers' understanding of reality is continuously evolving. Thus, reality was, is and will be hypothetical and imperfect, e.g., represented in terms of probabilities. The plausibility of researchers' rival hypotheses depends on context (historical, cultural, and social relativism). As Granger (1995, p. 103) stated, "scientific claims can be recused by science today or tomorrow". Research evidence represents reality, and is continuously transformed or replaced, incrementally or via Kuhnian paradigmatic revolutions (Granger, 1995).

EPISTEMOLOGY – Truthful scientific knowledge: There is and will be no scientific truth. Scientific knowledge is derived from the researchers' selection of the most plausible rival hypotheses. For instance, hypotheses concern complex causal relations between factors (conditions or features) and outcomes (impacts or outputs). In other words, researchers select hypotheses or generate hypotheses about new phenomena, e.g., explore people's subjective perception, conduct a study and produce more plausible hypotheses in terms of results. For his part, Granger (1995, p. 78) said that "scientific statements are proposed as partial and provisory trustworthy hypotheses" consisting of falsifiable approximations.

RESEARCH PURPOSE – Mainly to confirm hypotheses: Researchers aim to confirm/reject plausible hypotheses, or explore new candidate hypotheses, or both. They work in scientific communities to peer-review and assess the trustworthiness of their initial hypotheses, methods and results (refining and revising hypotheses). They work in social systems and scientific communities that combine physicalism and idealism (dualism) into research instrumentation, raw data, analytical techniques, and results. In line with Granger (1995), the purpose of science is to describe, explain, and predict.

METHODOLOGY – Mainly hypothetico-deductive: Research design, data collection and data analysis are influenced by researchers' judgments and multiple other sources of bias, e.g., study limitations. Methodology and methods choices are guided by research questions. They usually (but not necessarily) are hypothetico-deductive such as randomized controlled trials and non-randomized epidemiological studies. With regards to hypothesis generation, inductive and hybrid deductive-inductive methods can be used, such as exploratory machine learning studies, and confirmatory-exploratory descriptive qualitative research, respectively.

Social constructivism

While there are multiple variants of constructivism, MM scholars usually mix cognitive and social constructivism under the generic term of constructivism (Rees et al., 2020). We choose to focus on social constructivism as the most relevant variant to inform this report. Our definition of social constructivism is primarily based on the work of Ian Hacking, a Canadian philosopher who was considered the leading scholar of this worldview in the 1990s (Berger & Luckmann, 1966; Christ, 2013; Hacking, 1995, 1999, 2002; Lambert, 2006; Schwandt, 2001) and who edited a collective book with the most influential philosophers of science of the 20th century (Hacking, 1981). We illustrate this worldview using the work of Bruno Latour (1995), a world-renowned French sociologist regarding how research is performed and science is socially constructed in biology and physics laboratories.

ONTOLOGY - Ontological relativism: Researchers co-construct reality with study participants, resulting in multiple potential co-constructed realities grounded in points of view and life experiences. These co-constructions are limited by cultural, economic, educational, and social norms such as disease classifications. Classifications influence classified people who may, in turn, change the classifications. Hacking calls 'looping effects' the two-way feedback between the 'classification' and the 'classified', which lead to conceiving of realities as 'moving targets'. Regarding the construction of 'scientific facts', Latour (1995) provided many examples of researchers' contradictory results leading "to open more and more black boxes on conditions producing their results" (p. 81).

EPISTEMOLOGY - Inter-subjective knowledge: Researchers and stakeholders, e.g., patients and their entourage, construct scientific knowledge in an iterative manner. Knowledge consists of researchers' explanations of shared meanings (mixing personal experiences, community thoughts, social norms, and common knowledge). For example, they look for shared meanings in communities such as mixed kinds that integrate individual, social, and natural kinds (mixed kinds made by looping effects between different kinds). For example, Latour (1995, p. 103) stated that researchers cite, contradict or ignore each other, then "sometimes, a small number of publications are constantly used as references into publications containing the same claims", which means that a 'scientific fact' is being built.

RESEARCH PURPOSE – Mainly to explore new ideas: Research is constructed in scientific communities. Researchers mainly aim to develop conceptual and theoretical explanations. Specifically, for the most part, they aim to explore new ideas, although they may also endeavour to confirm some theoretical elements or to explore new elements in differing contexts. They may study participants' ideas and material matters (e.g., technologies) to build and revise concepts and theories. To do so, they adhere to the sociocultural conventions of their academic community (valuing exchanges with and approval of other researchers). "The production of [scientific] facts and machines is a collective process" (Latour, 1995, p. 79).

METHODOLOGY – Mainly inductive: Knowledge is constructed through interaction with others. Research design, data collection and analysis allow researchers to develop new theories based on interactional data, or to use theories to interpret data, and/or to revise theories using

data. Typically, two or more researchers work together to reach consensus on interpretations, stimulating reflexive thought and counter interpretations. Researchers usually (but not necessarily) use inductive methods, e.g., qualitative biography (narrative). They may also use other methods such as confirmatory-exploratory descriptive qualitative ones, exploratory quantitative surveys, or machine learning. By way of illustration, Latour (1995, p. 211) presented examples of the creation of 'new scientific objects' (induction) and their confirmation in other laboratories (deduction). The latter requires that researchers find allies among their peers.

Pragmatism

Pragmatism originated and was developed, for the most part, in North America (Azzopardi & Nash, 2014; Christ, 2013; De Waal, 2005; Dewey, 1998; Johnson & Onwuegbuzie, 2004; Kilpinen, 2008; Schoonenboom, 2019; Shannon-Baker, 2016). Our explanation of this worldview is guided by De Waal (2005)'s comprehensive essay on pragmatism. Pragmatism has been foundational to education research over the last 100 years (Dewey, 1998).

ONTOLOGY - Action-related views of reality (what works): Researchers focus on concrete actions such as people's behaviours, professional practices, services, and policies (e.g., education, health, and social activities). An action can refer to a singular reality, or multiple points of view and life experiences (conceived of as 'warranted assertions' by Dewey (1998)).

EPISTEMOLOGY - Action-based knowledge: Researchers derive knowledge from their analysis of participants' actions and seek to use this knowledge to improve these actions, e.g., developmental evaluation of programs with iterative cycles 'planning, implementation, evaluation, improvement'. Depending on the action under study and its context, researchers derive knowledge from plausible hypotheses, or subjective perceptions, or both (seen as falsifiable assertions by Dewey (1998)).

RESEARCH PURPOSE – To explore and/or confirm action-oriented practical solutions and meaning-making: Researchers aim to identify concrete solutions to improve a specific action (or set of actions) such as an individual's behaviour, a professional practice, a service, or a policy (e.g., educational, health or social activity). Their work can be exploratory, or confirmatory, or both. The research results are changes that involve material matters and thoughts, e.g., concepts. By way of illustration, Friedberg (1997), a French sociologist with expertise in organization studies, stated that the production of knowledge and its application are "intimately connected" (p. 33). Organizational research results have an impact when they help stakeholders to better understand their practice (called 'systems of concrete actions'), learn something new, and change their behavior. In turn, researchers can observe practice changes to reinforce and improve scientific knowledge.

METHODOLOGY - Action-centered inductive and/or deductive research design, data collection, and data analysis: The entire research process is guided by practical considerations for selecting the best method to study the specific action of interest. Also, researchers can integrate sources of bias and interactions with participants in the research process. Their work can be primarily deductive, primarily inductive, or equally deductive and inductive.

Critical theory

As Denzin (2010) stated, there are critical theories, i.e., multiple versions of the critical theory worldview, especially in MM. While the term 'critical theory' is old (as old as postpositivism and pragmatism), it is still useful to encompass all contemporary variants of critical theory, as "an umbrella term for a set of theories that aim to make social structure visible through an analysis of power relations" (Paradis et al., 2019, p. 843), specifically in MM (action research, feminism, gender theory, social capital, and transformativism) (Crasnow, 2019; Fehrenbacher & Patel, 2020; Fries, 2009; Ivankova, 2014; Mertens, 2012). In a critical theory worldview, MM are (a) aimed to improve cultural and social justice, (b) centered on power issues, e.g., resistance to dominant ideologies, and (c) based on empowerment of people and communities (Baškarada & Koronios, 2018; Denzin, 2010; Ma, 2012). As shown below, action-, emancipatory-, participatory-, and transformative-research can be seen as variants of critical theory. For example, three included MM reference articles were informed by the Bourdieu's approach to social change, centered on economic power issues and based on the empowerment of populations in situation of vulnerability (Fries, 2009; Harrits, 2011; Jones, 2017). In line with such objective, focus and social mechanism, two included reference texts mentioned that the attention to power imbalances between researchers and research participants are specific to 'action research' and 'participatory research' (Azzopardi & Nash, 2014; Ivankova, 2014); and three texts reported that feminist MM are aimed to end sexist research, centered on gender issues and based on women's emancipation (Heimtun & Morgan, 2012; Hesse-Biber, 2010; Tashakkori & Teddlie, 2010). Furthermore, Mertens defined the 'transformative' worldview (Mertens, 2012, 2017), which is (a) aimed at improving social justice and human rights, specifically the quality of life of those who experience poverty and discrimination (b) centered on power issues faced by marginalized communities, and (c) based on their emancipation and empowerment via involvement in MM as research partners at all stages. Mertens' term and definition have often been reported in the included texts (Biddle & Schafft, 2015; Christ, 2013; Creswell & Plano Clark, 2018; Creswell & Tashakkori, 2007; Greene, 2007; Hall, 2013; Heimtun & Morgan, 2012; Ivankova, 2014; Jackson et al., 2018; Plano Clark & Ivankova, 2015; Shannon-Baker, 2016; Tashakkori & Teddlie, 2010; Teddlie & Tashakkori, 2009).

Similar to other MM scholars, our definition of critical theory has been largely influenced by two leading critical theorists, Pierre Bourdieu (1993) and Jürgen Habermas (1987a, 1987b), a French and a German sociologist, respectively.

ONTOLOGY – Promotion of social justice: Critical theory promotes cultural, economic, educational, political, and social justice via a value-based critique of the society. Critical theory provides 'a priori' power structures and functions (historical, cultural, political, or social) for planning, conducting and appraising research. For instance, Habermas (1987a) opposes the social systems' colonization of the private 'life world' in our society versus the resistance of the latter. Bourdieu (1994), for his part, wrote "the real is relational" (p. 17), while "the experience of

[social] classes is a struggle" (p. 27); groups exist and are maintained "in and via differences" of social power and influence (p. 53).
EPISTEMOLOGY – *Representation of the voice and views of the oppressed:* Researchers combine (a) objective measures, e.g., cultural, economic, and social inequities, and (b) interactions with participants, including value-based subjective perceptions. They partner with participants, e.g., considered co-researchers or collaborators, to co-construct knowledge by sharing some or all research decisions, e.g., negotiate research questions and the interpretation, diffusion, dissemination, and application of findings in line with principles of empowerment, social justice, trust, and the critical theory being used (that is both 'a priori' and developed with data). For example, Habermas (1987b) conceives communication and knowledge as both a continuous exchange among, or combination of objective, normative and subjective arguments (Habermas, 1987b).
RESEARCH PURPOSE – To explore and/or to confirm the existence of and reduce inequities: Researchers aim to promote cultural, economic, educational, and social justice, and can be activists promoting human rights and societal changes. Researchers may work to implement or improve programs such as participatory management or empowerment support programs that seek to enhance individual and social well-being. Typically, researchers holding a critical theory worldview corroborate existing theoretical elements and explore new contextual elements. Also, promoting justice usually involves conceptual and material elements (idealism and physicalism). For example, Bourdieu (1994) sought to discover and critically examine differences and differentiation processes between social classes.
METHODOLOGY – Inductive and/or deductive participatory research: Research design, data collection, and data analysis are negotiated in line with principles of empowerment, social justice, and the critical theory being used. Researchers start planning studies with representatives of participants and stakeholders, according to a shared position (some positions are right, others are wrong). They negotiate with representatives the sources of bias and interactions with participants. They also negotiate with representatives the deductive, inductive, or deductive-inductive aspects of the research. For instance, Bourdieu (1993) used a diversity of inductive and deductive qualitative and quantitative methods to analyze relationships between people in terms of class-related dispositions (habitus) and decisions (choices) to behave in certain ways.

<u>Critical realism</u>
The fifth common worldview in MM is theory-based, and involves a specific type of theory: Middle-Range Theory (MRT) (Christ, 2013; Maxwell & Mittapalli, 2010; Merton, 1968; Pawson, 2006; Sayer, 2000; Shannon-Baker, 2016). Our definition is primarily informed by Sayer (2000), for whom critical realism borrows some principles from postpositivism and others from social constructivism. Practical details and examples can be found in Ellaway et al. (2020) and Jagosh et al. (2012).
ONTOLOGY - Ontological realism: Researchers' work is based on MRTs, which explains how programs work. They are neither micro theories, e.g., the logic model of a program, nor grand

theories, e.g., the Luhmann's theory of social systems (Luhmann, 1995). Researchers pose hypotheses that integrate a contextual contingent conception of reality and free will, e.g., people are constrained by norms, but can change them.
EPISTEMOLOGY – Epistemological relativism: There is and will be no scientific truth. Scientific knowledge is derived from researchers' hypotheses that are based on an initial MRT, which is then revised, refined, and improved using empirical research. Thus, findings consist of an improved MRT and MRT-based hypotheses, or testable propositions, for future research. They include configurational relationships between conditions and outcomes. Researchers generate trustworthy hypotheses using objective measures, or subjective perceptions, or both.
RESEARCH PURPOSE - Mainly to confirm and/or test an a priori MRT: Researchers aim to explain how and why programs work (process-oriented). In each 'Context-Mechanism-Outcome' (CMO) configuration, mechanisms are the generative forces that reflect the program stakeholders' reasoning (cognitive or emotional). Researchers aim to go beyond describing 'what happened' to theorizing 'how and why it happened, for whom, and under what circumstance' (i.e., they revise the initial MRT). Programs involve abstract ideas and material elements (dualism idealism and physicalism).
METHODOLOGY – MRT-driven deduction, induction, abduction, and retroduction: Research design, data collection, and data analysis are informed by the MRT and the study context. Researchers use the MRT to analyze data (deduction). They also use collected data to improve the MRT (induction). In addition, they draw inferences to complete missing data (hunch) with data that seem theoretically the most plausible (abduction and retroduction). Typically, they are (a) building CMO configurations describing a program, (b) grouping similar configurations in demi-regularities, i.e., regular patterns of program functioning, and (c) improving the MRT based on these demi-regularities.

Frequency of the reporting of worldviews in MM empirical studies.
Regarding the fourth objective, we described the frequency of the use of worldviews in MM empirical studies in patient-oriented research. We found all the common worldviews reported across the included studies (see Table 4). Among the 346 MM studies, 22 (6.4%) reported worldview-related sentences. We found MM publications reporting a single worldview, and publications reporting a combination of two (duos), three (trios) and four worldviews (quartets). For example, Holmes and Grech (2015, p. 389) stated that their study (a trio) "was informed by a critical [theory] paradigm and drew from both scientific [postpositivist] and interpretive [social constructivist] approaches".

Table 4. Worldviews and combinations of worldviews in the included mixed methods studies (n=22)

Worldviews	N	Combinations
• Pragmatism	6	Single
• Critical theory	2	Single
• Critical realism	1	Single
• Social constructivism	1	Single
• Postpositivism & Social constructivism	7	Duo
• Social constructivism & Pragmatism	1	Duo
• Postpositivism & Social constructivism & Pragmatism	2	Trio
• Postpositivism & Social constructivism & Critical theory	1	Trio
• Postpositivism & Social constructivism & Pragmatism & Critical theory	1	Quartet

CONCLUSION

The results of this literature review add to the existing knowledge in establishing that five contemporary worldviews are commonly used in MM research, and in distinguishing these worldviews from both historical positivism and radical constructivism which are deemed incompatible with MM research. In addition, we describe the frequency of the reporting of these worldviews and their combinations in a sample of MM empirical studies.

Typically, researchers describe their worldview according to only one worldview at the individual level. E.g., Fries (2009) used critical theory in a MM study on complementary and alternative medicine. Some leading scholars nevertheless report that their personal worldview combines at least two worldviews in a synergistic manner (hybrid worldview). E.g., Latour (2004) is renowned as a social constructivist and critical theorist. He stated that critical theory is necessary to overcome the limitations of relativism and subjectivity inherent to constructivism. Therefore, graduate students and novice researchers can decide that they stand with one worldview, or a hybrid combination of complementary worldviews.

Finally, in the companion chapter, we propose the *Framework and Aid for Combining Worldviews* for MM team research members, which offers six possible combinations of worldviews, and recommendations to select an appropriate combination. Practically, this can help MM graduate students and novice researchers to handle disruptive worldview-related tensions in MM research team and thesis committee meetings.

ACKNOWLEDGEMENTS

Reem El Sherif holds a doctoral fellowship from the Canadian Institute of Health Research (CIHR). Isabelle Vedel holds a Senior Scholar Award from the 'Fonds de recherche du Québec Santé' (FRQS). Authors gratefully acknowledge the contribution of students who attended the course FMED 608 (Advanced Mixed Methods), and of Paula Bush who edited the final version of this report.

REFERENCES

Alise, M. A., & Teddlie, C. (2010). A continuation of the paradigm wars? Prevalence rates of methodological approaches across the social/behavioral sciences. *Journal of Mixed Methods Research, 4*(2), 103-126.

Azzopardi, E., & Nash, R. (2014). An examination of philosophical paradigms and a rationale for adopting a mixed methods approach. *Tourism Analysis, 19*(2), 151-159.

Bachelard, G. (1993). *La formation de l'esprit scientifique*. Paris: Librairie philosophique J. Vrin.

Bachelard, G. (1999). *Le nouvel esprit scientifique*. Paris: Quadrige, Presses Universitaires de France.

Baškarada, S., & Koronios, A. (2018). A philosophical discussion of qualitative, quantitative, and mixed methods research in social science. *Qualitative Research Journal, 18*(1), 2-21.

Baumard, P. (1997). *Constructivisme et processus de la recherche : L'émergence d'une "posture" épistémologique chez le chercheur [conference paper]*. Paper presented at the Colloque Constructivisme et Sciences de Gestion, Lille.

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. Garden City: Anchor Books.

Bernard, C. (1966). *Introduction à l'étude de la médecine expérimentale*. Paris: Garnier-Flammarion.

Biddle, C., & Schafft, K. A. (2015). Axiology and anomaly in the practice of mixed methods work: Pragmatism, valuation, and the transformative paradigm. *Journal of Mixed Methods Research, 9*(4), 320-334.

Bourdieu, P. (1993). *La misère du monde*. Paris: Seuil.

Bourdieu, P. (1994). *Raisons pratiques: Sur la théorie de l'action*. Paris: Seuil.

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks: Sage.

Campbell, D. T. (1988). Can we be scientific in applied social science? In S. Overman (Ed.), *Methodology and epistemology for social science: Selected papers of Donald T. Campbell* (pp. 315-333). Chicago: The University of Chicago Press.

Christ, T. W. (2013). The worldview matrix as a strategy when designing mixed methods research. *International Journal of Multiple Research Approaches, 7*(1), 110-118.

Coates, A. (2021). The prevalence of philosophical assumptions described in mixed methods research in education. *Journal of Mixed Methods Research, 15*(2), 171-189.

Comte, A. (2003). *Discours sur l'esprit positif* (Vol. Paris): Librairie philosophique J. Vrin.

Crasnow, S. (2019). Feminism, causation, and mixed methods research. In S. N. Hesse-Biber & R. B. Johnson (Eds.), *The Oxford handbook of multimethod and mixed methods research inquiry*. Oxford: Oxford University Press.

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). Thousand Oaks: SAGE.

Creswell, J. W., & Tashakkori, A. (2007). *Differing perspectives on mixed methods research*. Thousand Oaks: SAGE.
De Waal, C. (2005). *On pragmatism*. Belmont: Wadsworth.
Delanty, G., & Strydom, P. (2003). *Philosophies of social science: The classic and contemporary readings*. Maidenhead: Open University Press.
Denzin, N. K. (2010). Moments, mixed methods, and paradigm dialogs. *Qualitative Inquiry, 16*(6), 419-427.
Dewey, J. (1998). *The essential Dewey (volume 1): Pragmatism, education, democracy*. Bloomington: Indiana University Press.
Ellaway, R. H., Kehoe, A., & Illing, J. (2020). Critical realism and realist inquiry in medical education. *Academic Medicine, 95*(7), 984-988.
Fehrenbacher, A. E., & Patel, D. (2020). Translating the theory of intersectionality into quantitative and mixed methods for empirical gender transformative research on health. *Culture, Health & Sexuality, 22*(sup1), 145-160.
Fetters, M. D. (2020). *The mixed methods research workbook: Activities for designing, implementing, and publishing projects* (Vol. 7). Thousand Oaks: SAGE.
Friedberg, E. (1997). *Le pouvoir et la règle: Dynamiques de l'action organisée*. Paris: Seuil.
Fries, C. J. (2009). Bourdieu's reflexive sociology as a theoretical basis for mixed methods research: An application to complementary and alternative medicine. *Journal of Mixed Methods Research, 3*(4), 326-348.
Gendron, S. (2001). *La pratique participative en santé publique: L'émergence d'un paradigme [PhD thesis]*. (PhD), Université de Montréal, Montréal.
Ghiara, V. (2019). Disambiguating the role of paradigms in mixed methods research. *Journal of Mixed Methods Research, 14*(1), 1-15.
Giddings, L. S., & Grant, B. M. (2007). A Trojan Horse for positivism?: A critique of mixed methods research. *Advances in Nursing Science, 30*(1), 52-60.
Granger, G.-G. (1995). *La science et les sciences*. Paris: Presses universitaires de France.
Greene, J. C. (2007). *Mixed methods in social inquiry*. San Francisco: Jossey Bass.
Habermas, J. (1987a). *Théorie de l'agir communicationnel : Pour une critique de la raison fonctionnaliste (tome 2)*. Paris: Fayard.
Habermas, J. (1987b). *Théorie de l'agir communicationnel : Rationalité de l'agir et rationalisation de la société (tome 1)*. Paris: Fayard.
Hacking, I. (1981). *Scientific revolutions* (Vol. 292). New York: Oxford University Press
Hacking, I. (1995). The looping effects of human kinds. In D. Sperber, D. Premack, & A. Premack (Eds.), *Causal cognition: A multidisciplinary approach* (pp. 351-383). Oxford: Oxford University Press.
Hacking, I. (1999). *The social construction of what?* Cambridge: Harvard University Press.
Hacking, I. (2002). Inaugural lecture: chair of philosophy and history of scientific concepts at the Collège de France, 16 January 2001. *Economy And Society, 31*(1), 1-14.
Hall, R. (2013). Mixed methods: In search of a paradigm. In T. Le & Q. Le (Eds.), *Conducting research in a changing and challenging world* (pp. 69-78). New York: Nova Science Publishers.
Harrits, G. S. (2011). More than method?: A discussion of paradigm differences within mixed methods research. *Journal of Mixed Methods Research, 5*(2), 150-166.
Heimtun, B., & Morgan, N. (2012). Proposing paradigm peace: Mixed methods in feminist tourism research. *Tourist Studies, 12*(3), 287-304.

Hesse-Biber, S. (2010). *Mixed methods research: Merging theory with practice*. New York: Guilford Press.
Holmes, T., & Grech, C. (2015). CaLD nurses transition to Australian tertiary hospital practice: Exposing the reality–A mixed methods study. *Collegian, 22*(4), 387-396.
Ivankova, N. V. (2014). *Mixed methods applications in action research*. Thousand Oaks: SAGE.
Jackson, K. M., Pukys, S., Castro, A., Hermosura, L., Mendez, J., Vohra-Gupta, S., . . . Morales, G. (2018). Using the transformative paradigm to conduct a mixed methods needs assessment of a marginalized community: Methodological lessons and implications. *Evaluation and Program Planning, 66*, 111-119.
Jagosh, J., Macaulay, A. C., Pluye, P., Salsberg, J., Bush, P. L., Henderson, J., . . . Herbert, C. (2012). Uncovering the benefits of participatory research: implications of a realist review for health research and practice. *The Milbank Quarterly, 90*(2), 311-346.
Johnson, R. B., Onewuegbuzie, A., & Turner, L. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133.
Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.
Jones, K. (2017). Using a theory of practice to clarify epistemological challenges in mixed methods research: An example of theorizing, modeling, and mapping changing west african seed systems. *Journal of Mixed Methods Research, 11*(3), 355-373.
Jonnaert, P., & Masciotra, D. (2004). *Constructivisme: choix contemporains: Hommage à Ernst von Glasersfeld* (Vol. 9). Québec: Presses de l'Université du Québec.
Kilpinen, E. (2008). *Pragmatism as a philosophy of action [conference paper].* Paper presented at the First Nordic Pragmatism Conference, Helsinki, Finland.
Kuhn, T. (1983). *La structure des révolutions scientifiques*. Paris: Flammarion.
Lambert, E. (2006). Hacking and human kinds. *Aporia, 16*(1), 49-71.
Latour, B. (1995). *La science en action*. Paris: Gallimard.
Latour, B. (2004). Why has critique run out of steam? From matters of fact to matters of concern. *Critical Inquiry, 30*(2), 225-248.
Luhmann, N. (1995). *Social systems*. Stanford: Stanford University Press
Ma, L. (2012). Some philosophical considerations in using mixed methods in library and information science research. *Journal of the American Society for Information Science and Technology, 63*(9), 1859-1867.
Maxwell, J. A., & Mittapalli, K. (2010). Realism as a stance for mixed methods research. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 145-168). Thousand Oaks: SAGE.
Mertens, D. M. (2012). Transformative mixed methods: Addressing inequities. *American Behavioral Scientist, 56*(6), 802-813.
Mertens, D. M. (2017). *Mixed methods design in evaluation* (Vol. 1). Thousand Oaks: SAGE.
Merton, R. (1968). *Social theory and social structure*. New York: Free Press.
Niglas, K. (2010). The multidimensional model of research methodology: An integrated set of continua. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (2nd ed., pp. 215-236). Thousand Oaks: SAGE.
Overman, S. (1988). *Methodology and epistemology for social science: Selected papers of Donald T. Campbell*. Chicago: The University of Chicago Press.

Paradis, E., Nimmon, L., Wondimagegn, D., & Whitehead, C. R. (2019). Critical theory: Broadening our thinking to explore the structural factors at play in health professions education. *Academic Medicine, 95*(6), 842-845.
Park, Y. S., Konge, L., & Artino, A. R. (2020). The positivism paradigm of research. *Academic Medicine, 95*(5), 690-694.
Pawson, R. (2006). *Evidence-based policy: A realist perspective*. London: SAGE.
Phillips, D. C., & Burbules, N. C. (2000). *Postpositivism and educational research*. Lanham: Rowman & Littlefield.
Piaget, J. (1964). *Six études de psychologie*. Paris: Denoel.
Piaget, J. (1970). *L'épistémologie génétique*. Paris: Presses universitaires de France.
Plano Clark, V. L., & Ivankova, N. V. (2015). *Mixed methods research: A guide to the field*. Thousand Oaks: SAGE.
Pluye, P., & Hong, Q. N. (2014). Combining the power of stories and the power of numbers: Mixed methods research and mixed studies reviews. *Annual Review of Public Health, 35*, 29-45.
Pluye, P., Hong, Q. N., Bush, P. L., & Vedel, I. (2016). The plurality of methods for reviews and syntheses: Opening-up the definition of systematic reviews. *Journal of Clinical Epidemiology, 73*, 2-5.
Pluye, P., Hong, Q. N., El Sherif, R., & Vedel, I. (in press). Combining scientific worldviews in mixed methods research. In P. Ngulube (Ed.), *Handbook of Research on Mixed Methods Research in Information Science*. Hershey: IGI Global.
Pluye, P., Kaur, N., Granikov, V., Garcia Bengoechea, E., & Tang, D. (2018). A world of possibilities in mixed methods: Review of the combinations of strategies used to integrate qualitative and quantitative phases, results and data. *International Journal of Multiple Research Approaches, 10*(1), 41-56.
Rees, C. E., Crampton, P. E., & Monrouxe, L. V. (2020). Re-visioning academic medicine through a constructionist lens. *Academic Medicine, 95*(6), 846-850.
Ridde, V., & Dagenais, C. (2012). Introduction générale à l'évaluation de programme. In V. Ridde & C. Dagenais (Eds.), *Approches et pratiques en évaluation de programme* (pp. 11-29). Montréal: Presses de l'Université de Montréal.
Sayer, A. (2000). *Realism and social science*. Thousand Oaks: SAGE.
Schoonenboom, J. (2019). A performative paradigm for mixed methods research. *Journal of Mixed Methods Research, 13*(3), 284-300.
Schwandt, T. A. (2001). *Dictionary of qualitative inquiry*. Thousand Oaks: SAGE.
Shadish, W. R., Cook, D. T., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Belmont: Wadworth.
Shannon-Baker, P. (2016). Making paradigms meaningful in mixed methods research. *Journal of Mixed Methods Research, 10*(4), 319-334.
Tashakkori, A., & Teddlie, C. (2010). *Handbook of mixed methods in social and behavioral research*. Thousand Oaks: SAGE.
Teddlie, C., & Tashakkori, A. (2003). Major issues and controversies in the use of mixed methods in the social and behavioural sciences. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 3-50). Thousand Oaks: SAGE.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. Thousand Oaks: SAGE.
Tyson, L. (2014). *Critical theory today*. New York: Routledge.
Von Glasersfeld, E. (2001). The radical constructivist view of science. *Foundations of Science, 6*(1-3), 31-43.
Weber, M. (1992). *Essais sur la théorie de la science*. Paris: Plon.
Young, M. E., & Ryan, A. (2020). Postpositivism in health professions education scholarship. *Academic Medicine, 95*(5), 695-699.

APPENDIX 1: HANDOUT FOR GRADUATE STUDENTS

WORLDVIEW	ONTOLOGY	EPISTEMOLOGY	RESEARCH PURPOSE	METHODOLOGY
Postpositivism	Realism (continuing evolution of the conception of reality).	Truthful scientific knowledge (but no truth).	Mainly to confirm hypotheses and generalize results of previous work, but sometimes to explore new ideas.	Mainly hypothetico-deductive, but potentially inductive. Biased data collection and analysis, e.g., influenced by researchers' values (influences at least partially controllable).
Social constructivism	Relativism (co-existence of different conceptions of reality).	Intersubjective knowledge.	Mainly to explore new ideas (e.g., discover new scientific theories), but sometimes to confirm patterns and/or theories from previous work (e.g., transfer theories in other contexts).	Mainly inductive, but potentially deductive. Interpretation of data influenced by researchers' and participants' values.
Pragmatism	Action-related conception of reality.	Action-based knowledge.	To explore and/or confirm practical solutions to better understand and improve action.	Action-centered inductive and/or deductive data collection, analysis and solutions (what works).
Critical theory	Promotion of social justice via scientific understanding and explanations of the oppression.	Knowledge representing the voice and views of the oppressed.	To explore and/or confirm and reduce inequities. To enact individual empowerment and social changes for marginalized groups for instance.	Inductive and/or deductive participatory research methodologies and methods. Research influenced by participants' beliefs and values.
Critical realism	Realism	Intersubjective knowledge.	Mainly to confirm and/or test an a priori Middle-Range Theory (MRT), but sometimes to explore new ideas for building a new emerging MRT (or improving an a priori MRT).	MRT-driven deduction, abduction, and retroduction (sometimes induction).

Handout from FMED 608 annual 1-credit course on scientific worldviews in mixed methods research (Department of Family Medicine, McGill University).