

State of Mixed Methods Research in Engineering Education: In-Depth Examination of JEE Articles, 2010-2015

Neha Choudhary and Brent K. Jesiek
School of Engineering Education
Purdue University
West Lafayette, USA
nchoudha@purdue.edu

Abstract— Mixed methods study designs can improve understanding of many research questions in ways not possible with only qualitative or quantitative methods. Yet despite its potential advantages, mixed methods research carries challenges related to added time and resources, research skill requirements, and justification hurdles. In recent years, scholars have started using mixed methods research to understand problems related to engineering education such as student retention, active learning, diversity, and classroom-based research. In this paper we report on an in-depth examination of mixed methods research articles published 2010-2015 in the *Journal of Engineering Education* (JEE). We found 12 qualifying articles that explicitly mentioned mixed methods in the abstract. To evaluate the identified studies we used a research process oriented framework that offers guidance for Good Reporting on a Mixed Methods Study (GRAMMS). The results from this in-depth examination of the selected JEE articles using the GRAMMS framework suggests that authors needed to be more explicit about the rationale behind using a mixed methods approach. It also suggests a need for more explicit focus on reporting the integration of qualitative and quantitative components. We expect our findings will be useful for researchers who are involved with carrying out and/or reviewing mixed methods studies, including by providing a view on the current state of the field and associated considerations for evaluating the quality of mixed methods research.

Keywords—Mixed methods research, multi-method research, qualitative, quantitative, research methods

I. INTRODUCTION

The body of mixed method research in the engineering education field has grown substantially in recent years. Mixed methods research designs have the potential to provide better understanding of problems beyond what is possible when studies are based on only qualitative or quantitative methods. Some of the advantages of using mixed method research include its: potential strength in offsetting the respective weaknesses of qualitative and quantitative methods, ability to provide more and better evidence when studying a research problem, help in answering questions that cannot be answered by quantitative or qualitative methods alone, and encourages

the use of multiple worldviews when performing research [1]. Yet in spite of such advantages, mixed methods research also carries challenges, including: expanded time and resource requirements; expanded skill sets; and the need to convince others of the need for and quality of this type of approach [1].

In recent years, scholars have started using mixed methods research to understand problems related to engineering education such as student retention, active learning, increasing diversity and classroom based research [2][3][4]. In fact, a quick search in the *Journal of Engineering Education* (JEE) using the keyword “mixed method research”, returns 258 results (articles that are published till now). In this paper we report on an in-depth examination of recent mixed methods research articles published in JEE, including to identify the research process used by the authors, and to compare these to the perspectives and characteristics typically understood to describe mixed methods research. To limit the scope of this paper, we are examining research papers published from the year 2010-2015. To further limit the scope, we used a specific logic that is using “mixed method” in the abstract field, we identified 12 articles which explicitly mentioned “mixed method” in the abstract. While there are several frameworks available to assist researchers in evaluating mixed methods research studies, in this paper we drew on prior work by O’Cathain et al. which proposes a research process-oriented framework that offers guidance for Good Reporting on a Mixed Methods Study (GRAMMS)[5].

This paper is organized in four major sections. The first section of the paper will include the discussion of definitions of mixed methods research by pioneers and leaders in the field. The second section turns to methods, including the selection and identification criteria of the JEE articles for this study. The third section presents the brief literature review and evaluation criteria used for in-depth examination of the selected JEE papers. A fourth and final section reports results from the our examination of the selected papers. The results from this in-depth examination of the selected JEE article, using GRAMMS framework, suggest that authors needed to be more explicit about the rationale behind using a mixed methods research. It

also suggests that there is a need to place greater emphasis on the reporting of integration of qualitative and quantitative component. Authors using mixed method approaches need to be more explicit about how and where integration occurs in the research design.

This in-depth analysis of the selected JEE article can be useful for the new researchers who are either in the process of writing and reporting mixed methods studies, or involved in reviewing mixed method studies. Specifically, this paper can help better understand the current state of mixed methods research in engineering education, as well as best practices for developing and evaluating high quality mixed methods studies.

II. DEFINING MIXED METHOD RESEARCH

Johnson and Onwuegbuzie (2007), asked many of the current leaders in mixed methods research how they define mixed methods research. Based on the analysis of these definitions, the authors proposed a tentative definition:

“Mixed methods research is an intellectual and practical synthesis based on qualitative and quantitative research; it is the third methodological or research paradigm. It recognizes the importance of traditional quantitative and qualitative research but also offers a powerful third paradigm choice that often will provide the most informative, complete, balanced, and useful research results.” [6]

In another definitional attempt, Creswell et al (2003) argued that mixed methods research involves both quantitative and qualitative data collection or analysis in a single study, including the integration of the data at one or more stages in the process of research [7]. According to Creswell and Clark, research problems best suited for mixed methods are those in which i) one data source is insufficient, ii) results need to be explained, iii) exploratory findings need to be generalized, iv) a second method needed to enhance the primary method, v) a theoretical stance needs to be employed and, vi) an overall research objective can be best addressed with multiple phases or projects.

Based on decisions regarding the implementation, priority, integration, and theoretical perspective, Creswell et al. (2003) additionally identified six mixed methods study designs: (1) sequential explanatory; (2) sequential exploratory; (3) sequential transformative; (4) concurrent triangulation; (5) concurrent nested, and (6) concurrent transformative. [7] The authors also suggested that these six variants of mixed method design give scholars the flexibility to choose and innovate within the types to fit a particular research situation. These definitions suggest that a mixed method research is the third methodological paradigm that provides strengths that potentially offset the weaknesses of the qualitative and the quantitative research paradigms. It also suggests that a mixed method study should integrate the methods in any of the stages of one study that could be data collection stage, data analysis and/or interpretation stage. In the following section of this article, we will discuss selection and identification criteria of the JEE articles for this paper.

III. SELECTION AND ANALYSIS CRITERIA

For this paper we decided to select and analyze recent mixed methods research papers published in the *Journal of Engineering Education* (JEE). The main reasons for choosing this journal is its quality and ranking among other journals within and beyond the field. JEE has an impact factor of 2.059 and according to ISI Journal Citation Reports has been ranked 7 of 37 in the Education Scientific Disciplines category, 13 of 85 in Engineering Multidisciplinary, and 18 of 224 Education & Educational Research [8]. Another reason for choosing this journal was the authors' familiarity with this journal. Additionally, we selected papers published in JEE from 2010-2015 to focus on more recent mixed methods research and to keep the scope of our effort more manageable. An initial search using “mixed methods” as a keyword and limiting publication duration between 2010-2015 resulted in 95 candidate articles. We used content analysis method and filtered only those article that explicitly mentioned mixed methods research in their abstracts, excluding all others. We also excluded any editorial or other commentaries from the study. Using this search logic (i.e., “mixed methods” in abstract and year published “2010-2015”), we identified 12 qualifying articles. Of these 12, only one article mentioned “mixed-methods study” in the title field, and 7 articles identified the type of mixed methods design (concurrent or sequential) in the methods section of the paper.

In the next section of this paper we discuss the brief literature review, rationale for choosing framework and evaluation criteria used for the in-depth examination of the selected JEE articles. It is also worth noting that one of the identified articles was multi-method rather than mixed methods study, thus we did not include it in the final analysis table. According to Morse, a multi method study could include multiple qualitative or quantitative methods and data sets in a single study [9]. It is different from a mixed methods study in which a single study integrates results from qualitative and quantitative methods and/or data sets. Thus the final in-depth examination includes 11 JEE articles.

IV. LITERATURE REVIEW AND EVALUATION CRITERIA

As the mixed methods research is increasing in engineering education field, the need evaluating the state of existing mixed methods literature is also increasing. Fortunately, many studies have examined quantitative and qualitative research accepted as rigorous in the field[10] but little work has been done on the extent that mixed methods research has been utilized by researchers in engineering education. There are several frameworks available to assist researchers in evaluating mixed methods research studies. In the mixed methods literature, we identified three kinds of criteria for evaluating mixed method studies namely: *a method orientation* [11], *the timing of phases of the investigation orientation* [12] and, *a research process orientation* [5]. The first criteria i.e. *method orientation* proposed by Creswell and Plano Clark. They proposed four steps process for evaluating mixed methods research. The first step recommends to look into the method section to identify whether the mixed method study has collected both qualitative and quantitative data used in the response to research questions or hypotheses. The second step suggests to look into the

TABLE I: REVIEWED ARTICLE LISTED AS MIXED METHODS

Paper ID	Author and Year Published	Paper title	Quantitative data collected	Qualitative data collected	Mixed method design
1	Amelink et al 2010 [2]	Gender Differences in Elements of the Undergraduate Experience that Influence Satisfaction with the Engineering Major and the Intent to Pursue Engineering as a Career.	Online questionnaire	Focus group interview	Concurrent mixed methods
2	Lathem et al, 2011 [13]	The Socially Responsible Engineer: Assessing Student Attitudes of Roles and Responsibilities.	Survey	Open-ended survey responses and interviews with faculty, students, and focus groups	Longitudinal, concurrent mixed method
3	Purzer, 2011 [14]	The Relationship Between Team Discourse, Self-Efficacy, and Individual Achievement: A Sequential Mixed-Methods Study.	Survey	Verbal exchange recording	Sequential mixed method
4	Taraban et al, 2011 [15]	Using Paper-and-Pencil Solutions to Assess Problem Solving Skill	Frequency counts of skill indicators and grader-assigned scores	Paper-and-pencil solutions and video recordings	Mixed experimental methodology
5	Allendoerfer et al, 2012 [16]	Strategic Pathways for Success: The Influence of Outside Community on Academic Engagement	Survey	Focus group interview	Does not mention
6	Brawner et al, 2012 [3]	Women in Industrial Engineering: Stereotypes, Persistence, and Perspectives	Large longitudinal dataset	Focus group and content analysis	Does not mention
7	Crede et al, 2012 [17]	Learning in Graduate Engineering Research Groups of Various Sizes.	Online survey	Ethnographic observations	Sequential exploratory
8	Trytten et al, 2012 [18]	“Asians are Good at Math. What an Awful Stereotype”: The Model Minority Stereotype’s Impact on Asian American Engineering Students.	Academic transcript data, survey	Semi-structured interviews	Does not mention
9	Ahn et al, 2013 [4]	Creating an Instrument to Measure Leadership, Change, and Synthesis in Engineering Undergraduates	Survey	Interview and constant comparative content analysis	Sequential exploratory
10	Besterfield-Sacre et al, 2014 [19]	Changing Engineering Education: Views of U.S. Faculty, Chairs, and Deans	Survey	Open ended responses in survey	Concurrent triangulation mixed methods
11	Matusovich et al , 2014 [20]	Faculty Motivation: A Gateway to Transforming Engineering Education	Close ended survey	Observational notes, open-ended written responses submitted after conference sessions, open-ended survey questions	Concurrent mixed methods study design

methods section again in detail to examine for rigor and persuasiveness, depending on the type of methods used. The third step recommends to examining how the mixing of data was completed and where the mixing occurred. Last step suggests to look whether study have made a conscious effort to describe mixed methods typology. The second criteria for

evaluating a mixed method research is proposed by Schifferdecker and Reed, based on the *timing of phases of the investigation* orientation. Schifferdecker and Reed presented seven recommendations for steps to be taken in designing, analyzing, and publishing mixed methods studies. These recommendations include a) identify the study design as mixed

methods; b) decide on the prominence of each data type in data collection, analysis, and results; c) develop sampling strategies that provide adequate data and adhere to guidelines within the methods chosen; d) decide how and when data are collected, analyzed, and integrated; e) set realistic time requirements for each project phase; f) explore software programming tools or methods to integrate the quantitative and qualitative data and; g) review mixed methods research articles to generate ideas for reporting results and displaying data. Although, this criteria is useful for ensuring some degree of quality of a mixed methods research study but it is different from other criteria as it focuses heavily on the data types and collection process. The last criteria which we found in mixed method study is proposed by O’Cathain, Murphy, and Nicholl (2008) [2]. They provided a framework for evaluating a mixed method research. This frame work formally known as Good Reporting of a Mixed Methods Study (GRAMMS). This framework provides a research process orientation. According to this framework a good mixed methods study should:

- a) describe the justification for using a mixed methods approach to the research question;
- b) describe the design in terms of the purpose, priority, and sequence of methods;
- c) describe each method in terms of sampling, data collection, and data analysis;
- d) describe where integration has occurred, how it has occurred, and who has participated in it;
- e) describe any limitation of one method associated with the presence of the other method; and
- f) describe any insights gained from mixing or integrating methods. [5]

While exploring mixed methods literature in the field of engineering education, we found two studies that stand out in evaluating mixed methods research and providing recommendations to improve the state of the fixed methods research. The first study that stands out was conducted by Crede and Borrego in 2010 [21]. In this study authors conducted a content analysis of selected articles in engineering education filed published from 2005 to 2010 to understand the state of mixed methods research in the field. For their analysis, they collected and analyzed 16 articles from 7 engineering education related journals. In the quantitative phase, authors used subset of four criteria established by Creswell for mixed method research design: i) collection of both qualitative and quantitative data; ii) analysis of both data presented; iii) priority and; iv) and timing of the data collection[9]. In the qualitative phase they used constant comparison method to systematically analyze the data and arrive at conclusions. They found that quantitative data was prioritized over qualitative data, most studies used a sequential design where the two strands were not collected together, and there was a lack of consistent terminology among researchers related to mixed methods research. They also observed the frequent use of surveys as the quantitative data source. In addition, they noted that little to no justifications for mixed methods were given and

that as a whole, the field needed to improve on the use of mixing.

The second study that stands out is conducted by Kajfej and Creamer, 2014. They conducted mixed methods content analysis of the mixed methods research literature in engineering education and to evaluate their quality in terms of their methodological consistency with contemporary definitions of mixed methods research[22] . Authors collected and analyzed 16 mixed methods research articles published from 2005-2011 in three major engineering education publications. They used convergent sequential content analysis to evaluate the sampled mixed methods research articles. In this two phase analysis (Rationale and Evaluation), authors found that many of the selected mixed methods articles did not provide a clear and supported rationale for why mixed method is used. They also noted that there is a lack of common terminology and common conventions for presenting mixed methods work in publications. Authors also found that there is a lack of framing mixed methods research questions. They found that none of the selected articles have had a mixed methods research question. Both of these studies found the need of providing justification for mixed methods and lack of common terminology related to mixed method research. In addition to that, Kajfej and Creamer, found the lack framing mixed method research questions. These findings provide good examples of evaluating mixed methods research and recommendations for reporting mixed methods research.

Based on the findings of these studies and the above discussed three evaluation criteria that provide extensive suggestions/guidance/recommendations to evaluate mixed methods studies, we decided to look on the current state of the mixed methods research published in the journal of engineering education. As both of the studies evaluated mixed methods articles published within 2005-2010, we decided to analyze the articles published from 2010-2015. The two studies discussed above used method oriented criteria proposed by Creswell and Plano Clark for evaluating mixed methods research. For this study, we looked at the selected JEE mixed methods articles through the lenses of a research process oriented framework i.e. GRAMMS framework proposed by O’Cathain. One of our reasons for choosing this framework for evaluating selected JEE papers is its ability to evaluate the research process. For our study, GRAMMS frame work allows to assess the qualitative and quantitative components separately because they each contribute to the study as a whole and because the quality of one or both components may suffer as a consequence of being part of a mixed methods study[22][24][25]. In addition to the individual components, this framework allows the assessment of the overall design quality, the integration of both the components and the inferences from integrating the methods. As the name suggests, this framework provides the guidelines for good reporting of a mixed methods study. Each criteria looks at the different phases of the research study and provides a good mechanism to evaluate the whole mixed method research process. In this paper we examined selected JEE articles based on six criteria provided in GRAMMS framework. In the next section of this paper we will discuss the in-depth examination of the selected JEE papers using the GRAMMS framework.

V. IN-DEPTH EXAMINATION OF SELECTED JEE ARTICLES

To perform in-depth examination of the selected JEE articles, we read each section of the articles. We used qualitative content analysis method to analyze the selected JEE articles. While analyzing the selected JEE article, we looked at each section of the selected article and evaluate it on the basis of the six criteria of GRAMM framework. We used deductive coding and all of the six categories are merged from the GRAMMS framework. These categories were: i) Conceptualization and justification of the study as mixed methods; ii) design quality; iii) adherence to respective standards for qualitative and quantitative methods throughout the study; iv) Adherence to standards for mixed method study v) Quality of analytic integration and; vi) Quality of interpretation. First we examined whether the article provides the justification of mixed methods grounded in literature, then we looked whether the article mentioned the mixed method design to ensure the quality of mixed method design. After that we looked if the article describes each method (qualitative and quantitative) in detail. Then we looked if the article have describe the integration of both methods and at the end we looked whether the article have incorporated the interpretation from both methods and incorporated inferences from the findings from the both the data sets. In this section we report results from analysis of the selected mixed methods JEE articles using the GRAMMS framework. While we do not provide a summary for each paper, Table I represents the information about the selected JEE article that includes name of the author, title of the article, what kind of qualitative and quantitative data has been collected and what mixed method design has been used in the article. More detailed information about the in-depth analysis of JEE mixed methods articles is presented in the Table II. Each column of the table represents the six deductive categories derived from six criteria of GRAMMS framework and each row represents the selected JEE article with the year of publication. We also included the example codes from most of the selected JEE articles for justification of mixed method, design quality and integration of both the methods. Those quotes are represented in bold and italic font. These quotes represent the good reporting strategies of mixed methods study.

VI. DISCUSSION

In this study, we have selected and examined 12 mixed methods research papers published in JEE from 2010-2015. The total number of paper published in JEE in the year 2010-2015 were 195, out of which 95 (48%) papers have been identified as potential mixed methods papers using the search keyword “mixed method” on the journal’s website. To keep a manageable scope, we narrowed our focus to only those papers that mentioned “mixed method” or similar terms in their abstracts. We found only 12 of those 95 articles explicitly mentioned mixed methods in their abstracts. By limiting the scope of this paper, we were able to analyze selected JEE paper in considerable depth. Through this in-depth examination of 12 JEE articles, we found that only four articles provided the rationale for using a mixed methods study design. Out of those four articles only one article (Trytenn et al, 2012) linked the rationale for using a mixed

methods approach to the theoretical paradigm. This evaluation also reveals that most of the articles (8 of 12) identified the type of mixed methods design and their design was aligned with their research questions. We also found the majority of the articles (7 of 12) did not consider and address the divergent findings or similar biases from each of the components. This finding differs from other two studies mentioned in the literature review in the sense that this framework allows to look into the research process to identify whether authors addresses divergent finding or similar biases from each of the components. One of the weakest points found was that most of them (9 of 12) did not mention where and how integration of each study component took place. This finding aligns with previous mixed method evaluation studies that discusses the lack of reporting of mixing the data. Last but not the least, using the GRAMMS framework we found that in all of the selected JEE articles, the authors were deliberate in their interpretation from each data set and clearly identified which findings emerged from which data set.

VII. CONCLUSION

In conclusion, this in-depth examination of 12 recent JEE article using the GRAMMS framework suggests that authors needed to be more explicit about the rationale behind using mixed methods study designs. It also suggests that there is a need to focus on the reporting of integration of qualitative and quantitative components. Authors using mixed methods approaches need to be more explicit about how and where integration occurs in their research designs. This findings reported here may be useful for the new researchers who are in the process of writing and reporting mixed methods studies, involved in reviewing mixed methods studies, and/or teaching mixed methods research approaches in graduate-level courses.

TABLE II. IN-DEPTH EXAMINATION OF JEE ARTICLES

Selected JEE Articles	GRAMMS CRITERIA					
	Conceptualization and justification of the study as mixed methods	Design quality	Adherence to respective standards for qualitative and quantitative methods throughout the study	Adherence to standards for mixed method study	Quality of analytic integration	Quality of interpretation
Amelink et al 2010 [2]	Authors did not provide explicit sound rationale for using mixed method research for this study.	Authors used concurrent embedded design for this study and explicitly provide description of the design. Design aligned with the research questions.	Authors provided full description of qualitative as well as quantitative component with regard to sampling, data collection and analysis.	Authors adequately identified and plausibly explained divergent findings from qualitative as well as quantitative components. Authors did not mention any biases between methods.	The authors explicitly mentioned that integration occur in the interpretation phase of this study and results from integration generate more comprehensive findings then either component would alone.	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.
Lathem et al, 2011 [13]	Authors did not provide explicit sound rationale for using mixed method research for this study.	Authors used longitudinal concurrent mixed method design and this design was appropriate for the research questions.	Authors provided full description of qualitative as well as quantitative component with regard to sampling, data collection and analysis.	Authors did not mention anything about the divergent findings from any of the components. No biases from any of the component has been considered and addressed.	Authors did not mention where the integration took place. Also they did not clarify which type of design they used for the integration of finding.	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.
Purzer, 2011 [14]	Author mentioned the rationale behind using mixed method for this study. <i>"...study uses a mixed-methods approach to gain a deeper understanding of six teams and uses a framework that combines two well-established learning theories that integrate social and affective factors"</i>	Author used sequential mixed method design and provided appropriate rationale for using this design. <i>"A sequential mixed-methods approach was used for data analysis (QUAL _QUAN). This enabled the researcher to connect the two datasets through a meaningful and sequential analysis"</i>	Authors provided full description of qualitative as well as quantitative component with regard to sampling, data collection and analysis.	Authors adequately identified and plausibly explained divergent findings from qualitative as well as quantitative components. <i>"The qualitative data analysis methods (discourse analysis) addressed the question of what types of discourse students engaged in, and the quantitative methods (correlations) helped reveal any significant correlations between student discourse actions, self-efficacy, and achievement."</i>	Author used visual representation to mention that findings from Qualitative component used to inform Quantitative component of the study.	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.
Taraban et al, 2011 [15]	Authors explicitly mentioned the rationale behind using mixed method for this study. <i>"By complementing information on students' solution sheets with information from the videos, the</i>	Authors used mixed experiment methodology design and provided appropriate rationale for using this design. <i>"...it was possible to apply experimental methodologies in order to empirically</i>	Authors adhered to the established standards for each component with regard to sampling, data collection and analysis.	Authors did not mention anything about the divergent findings from any of the components. Authors briefly mentioned about biases from each component.	Authors did not mention where the integration took place but they mentioned that <i>"they quantified the qualitative data in order to get more generalized findings."</i>	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.

	<i>analyses went beyond the information directly available to an instructor."</i>	<i>distinguish between higher- and lower-performing students based on their cognitive processes."</i>				
Allendoerfer et al, 2012 [16]	Authors did not provide explicit sound rationale for using mixed method research for this study.	Author did not mention which mixed method design they used for this study but from the description of this paper it is evident that they used sequential design.	Authors adhered to the established standards for each component with regard to sampling, data collection and analysis. However, we found some discrepancy in sample size (initially they mentioned 750 and later in the paper sample size mentioned was 791)	Authors did not mention anything about the divergent findings from any of the components. No biases from any of the component has been considered and addressed. Authors briefly mentioned about biases from each component.	Authors mentioned that analysis of the survey data guided development of the focus group protocol, as well as the analysis of the focus group data. Thus we assumed that integration took place in while collecting and analyzing data for qualitative phase.	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.
Brawner et al, 2012 [3]	Authors mentioned the rationale behind using mixed method for this study. <i>"...Using these qualitative data as part of our overall analysis helps us to validate, interpret, clarify, and illustrate the quantitative findings from MIDFIELD"</i>	Author did not mention which mixed method design they used for this study but from the description of this paper it is evident that they used sequential exploratory design which is suited for this study.	Authors provided full description of qualitative as well as quantitative component with regard to sampling, data collection and analysis.	The findings from one component were used to inform another, but authors did not consider and address any biases from any of the component.	Authors mentioned that using qualitative data as part of our overall analysis helped then <i>"to validate, interpret, clarify, and illustrate the quantitative findings"</i> . Thus we assume that integration occurred in the analysis and interpretation phase.	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set
Crede et al, 2012 [17]	Authors did not provide rationale behind using mixed method for this study.	Author used sequential exploratory mixed method design and provided appropriate rationale for using this design. <i>"The qualitative and quantitative data were collected and analyzed sequentially, with priority given to the qualitative findings."</i>	Authors adhered to the established standards for each component with regard to sampling, data collection and analysis.	The findings from one component were used to inform another, but authors did not mentioned and address any biases from any of the component.	Authors did not mention explicitly where the integration took place.	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.
Trytenn et al, 2012 [18]	Author mentioned the rationale behind using mixed method for this study. <i>"...Critical race theory shaped the rationale for using mixed methods for the study."</i>	Authors did not mention which mixed method design they used for this study.	Authors adhered to the established standards for each component with regard to sampling, data collection and analysis	Authors did not mention anything about the divergent or similar biases from any of the components.	Authors did not mentioned where and how the integration took place.	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.
Ahn et al, 2013 [4]	Authors did not provide explicit sound rationale for using mixed method research for this study.	Authors used sequential exploratory design for this study. <i>"We selected this design because it is often used when there is a need to generalize exploratory findings , develop and test a new</i>	Authors adhered to the established standards for each component with regard to sampling, data collection and analysis.	Authors adequately identified and plausibly explained divergent findings from qualitative as well as quantitative components.	Authors did not mention where and how the integration took place.	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.

		<i>instrument, and generalize qualitative results to different groups”</i>				
Besterfield-Sacre et al, 2014 [19]	Authors did not provide explicit sound rationale for using mixed method research for this study.	Authors used concurrent triangulation design for this mix method study and provide appropriate rationale for it. <i>“The survey was concurrent because it allowed for simultaneous collection of both quantitative and qualitative data. It was a triangulation design because the quantitative and qualitative data were given equal weight in the analysis.”</i>	Authors adhered to the established standards for each component with regard to sampling, data collection and analysis.	Authors adequately identified and plausibly explained divergent findings from qualitative as well as quantitative components.	This is the only article which had a separate section for integration. Integration took place at analysis and interpretation phase .	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.
Matusovich et al , 2014 [20]	Authors did not provide explicit sound rationale for using mixed method research for this study. <i>“we combined quantitative and qualitative data from two engineering education conferences to address the research questions of this study”</i>	Authors used concurrent mixed method design and provided appropriate rationale for it.	Authors adhered to the established standards for each component with regard to sampling, data collection and analysis	Authors adequately identified and plausibly explained divergent findings from both the components	Authors mentioned where and how the integration took place. <i>“Mixing of the data sets occurred during the analysis and interpretation phases, when all findings were explored through the lens of EVT”</i>	The authors were deliberate in their interpretation from each data sets and clearly identified which findings emerged from which data set.

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