A Worksheet Method for Developing Research Questions: An Examination of Three Graduate Student Cohorts

Vetria L. Byrd
Computer Graphics Technology
Purdue University
West Lafayette, IN, USA
000-0002-0733-2062

Jorge D. Camba
Computer Graphics Technology
Purdue University
West Lafayette, IN, USA
0000-0001-5384-3253

***Abstract*—In this full paper, we describe a design activity method for developing research questions and present a study on student's perception to validate it. We examine, compare and discuss results from three different graduate student cohorts (first, second, and third semester Master's degree students) who used the worksheet method at different stages of their graduate careers. The method is designed to help students identify topics, think critically about the underlying questions to explore a topic, identify a problem to be addressed by the research, and identify data sources to facilitate the research effort. The four stages are introduced as an incremental scaffolding process. Preliminary results showed graduate students found the worksheets effective in helping to develop research questions. This work contributes to the development of research practices and pedagogy supported by sound research questions.**

Keywords—research questions, educational theories, worksheet method, graduate students, scaffolding

I. INTRODUCTION

New researchers, specifically graduate students, often struggle with developing good research questions. The purpose of this study is three-fold. The first aim is to introduce an activity worksheet approach for developing research questions. The second aim is to assess students' perception of the usability and effectiveness of the design activity worksheet method. The third aim is to provide educators with insight as to what parts of the process should be scaffolded to meet students' experience with identifying and transforming topics into sound research questions. The main research questions are "At what point is the worksheet method most effective and when should the worksheets be introduced?"

In this paper, we examine students' perceptions on the use of the proposed method in the context of a study with 49 students (first, second, and third semester Master's degree students) enrolled in a graduate research seminar in a research-intensive university in the Midwest in the United States.

The paper is structured as follows: first, the theoretical foundations of the proposed method are discussed. Second, the content and development of the design activity worksheets are described, emphasizing the scaffolding aspects of the delivery. Next, the design, analysis, and results of our study are presented, followed by a discussion on the impact on graduate education. Our research contributes to better inform educational practice and pedagogy in research methods. The implications of this work can help students to understand the process of developing research questions, potentially improve the quality of student research, and advance the science in engineering and computing education.

II. BACKGROUND

A. Theoretical Underpinnings

Previous studies of research preparation range from studies on the role of framing research questions [1], to developing student research capability [2] and empowering and motivating students through the process of developing publishable research [3]. Trede and Higgs (2009) described research as the pursuit of knowledge through questioning and explore the framing of research questions and the role research questions play in the research. Trede and Higgs' (2009) work primarily focus on qualitative research; however, the knowledge and process of framing questions is transferable. The authors discuss various approaches, commonly utilized to develop research questions like identifying gaps in research or further developing an existing idea – "some researchers start with a research question whereas others wait for questions to emerge during data collection and analysis," [1]. Trede and Higgs (2009) report, "framing research questions is an activity that accompanies researchers throughout the lifespan of a research project." The framing of research questions is a very important aspect of the research process. It is of key importance in developing a congruent research design [1]. The worksheet method presented in this work provides a mechanism for iterative refinement of research questions to include incremental knowledge gained throughout the process. This aspect of the research process is necessary but often difficult for new researchers, students in particular.

Hughes (2019) identified three challenges with integrating research-based learning: (1) conceptualizing the research skills and progression is not easy, (2) the accumulation and enrichment of research skills is not readily visible to students

and (3) providing a clear support system is not straightforward. Ultimately, producing publishable-quality work [3] is a desirable outcome for research. The work of ([1] – [2]) capture various elements of the complex research process. There are universal guidelines (the scientific method and the engineering design process, for example) for doing research, but there is no universal approach for how students take in knowledge. In this work, we try to capture the essence of four initial stages of the research process to motivate students to think critically and more deeply about research topics they choose, and develop on their own or use the approach to further explore topics related to research underway when joining an existing research team.

Several learning frameworks support the underpinnings of the method described in this work. The behaviorist learning orientation is particularly useful for the development of competencies [4]. Behaviorism focuses on the mastery of prerequisite steps before moving on to subsequent steps [5]. Specific behavioral objectives allow the student to know exactly what behavior will be learned, the conditions under which the behavior will be performed, and the criteria in which it will be evaluated [4]. In the context of this work, completing the first proposed worksheet (condition), "Identifying Topics," will guide students through the process of discovering several topics then ranking them (performance), based on the student's articulation of what is known and unknown about the topic (criteria).

The cognitivist learning theory is characterized by the creation of meaningful learning through which learners seek to understand the structure of knowledge [4]. In the context of this work, the goal is to motivate students to gain a deeper understanding of the topics they choose. Most students can easily find a topic among their interests. However, most are oblivious to the manageability of the scope of the topics they choose and need guidance on how to question the topic to find the makings of a problem that can guide their research [6]. The goal of the cognitivist approach is to develop the learner's capacity and skills for more effective self-directed learning [4]. In the context of this work, the first and second worksheets, *"Identifying Topics"* and *"From Topics to Questions,"* utilize cognitive learning methods to facilitate critical thinking [7]. The *"Identifying Topics"* worksheet asks students to consider what they think they know about their topic and more importantly, what they do not know about the topic. Having an understanding of what is not known is equally important as knowing, especially in research. The "*From Topics to Questions*" worksheet facilitates "Habits of mind" practices [8] and intelligent behaviors [6] with questioning and problem posing to find out what the student needs to learn about the topic, in order to help the reader, gain a deeper understanding of the topic.

Questioning and posing questions informs the makings of a problem that can guide the students' research [6]. The third worksheet, *"From Questions to a Problem,"* utilizes the constructivist learning process, which involves construction of meaning from experiences through critical reflection on the learner's assumptions [4]. Each worksheet challenges students to identify specific aspects about their topic that may not have been explored before. We adopt the locus of learning in a constructivist approach which is internal and involves creating new ideas to change perspectives and deepen understanding [4]. In the context of this work, the worksheets motivate students to think about their own experiences as they relate to their topic, consider possible consequences and articulate the significance of their proposed work.

The last worksheet, *"From a Problem to Data Sources,"* utilizes elements of constructivist learning theory. Connectivism stresses that two important skills that contribute to learning are the ability to seek out current information, and the ability to filter secondary and extraneous information [10]. Constructivism is not a single viewpoint but rather has different perspectives [11 – 13]. It underlines the emphasis on students studying a topic from multiple perspectives [14] and enables scaffolding [15] of content. Connectivism (also referred to as distributed learning) is proposed as a more adequate theory for a digital age, when action is needed without personal learning, using information outside of primary knowledge [16]. In the context of this work, the "*From a Problem to Data Sources*" leverages students' self-directed quest for content by asking students to plan, generate, determine the viability and availability of data for their research. All of these skills are essential for developing sound research questions and carrying out the research. The educational theories utilized in each worksheet are shown in Figure 1.

B. Rationale for multiple learning theories

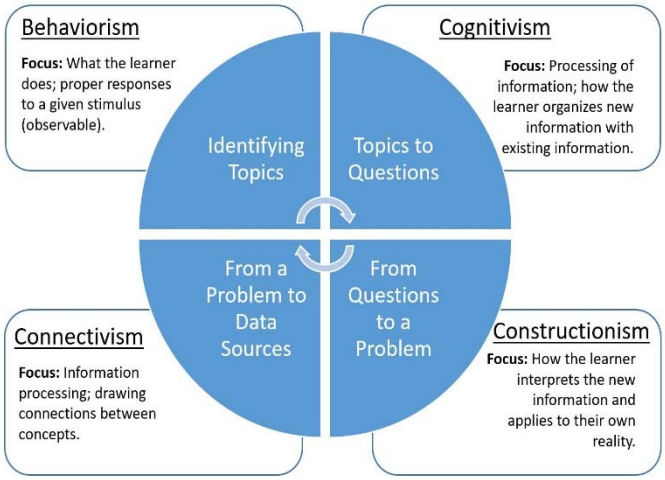

Fig. 1. Educational theories mapped to each worksheet.

The design model in Fig. 1 and related worksheets closely resemble the main phases of inquiry based-learning [17]. The model provided could also be likened to socio-constructivist learning theory. Socio-constructivist teaching and learning models emphasize the importance of social interactions in acquisition of skills and knowledge [18]. This paper reports outcomes from an individual student-centered approach that did not incorporate social constructivism. The basic premise of constructivism, that learners construct understanding, underlies many learning principles [14]. In this work we take a hybrid approach. For many students enrolled in the graduate seminar, the course is one of the first graduate courses that introduce research methods. Students enrolled in the graduate seminar have various degrees of understanding of what research is and the complex inquiry process used to support it. For this work, a

teacher-centered teaching approach [19], grounded in behaviorism and cognitivism, introduces the first two worksheets (Identifying Topics and Topics to Questions) as a guided baseline for future inquiry and support pre-defined goals and objectives of the worksheets. Viewing this part of the process through the lens of behaviorism and cognitivist theories allows for, what we perceive as, a progressive thought processes towards developing research capacity. We contend, at this stage, the individual learner is more than a passive listener but is in the formative stage of knowledge building [20]. The worksheet method presented here provides a guided introduction to knowledge building for strengthening students' research capacity. Knowledge building makes a distinction between knowledge *of* and knowing *about* something. Scardamalia and Rereiter [20] explains,

> knowledge *about* something consists of all the declarative knowledge you can retrieve when prompted to state what you know *about* something (a research topic, for example). Knowledge *about* something has value independently of skill and understanding. Knowledge *of* something, however, implies an ability to do or to participate in the activity. It consists of both procedural knowledge (how to do something) and declarative knowledge that would be drawn on when engaged in the activity. (pp 101).

Towards the hybrid teaching and learning approach adopted in this work, a learner-centered instructional strategy [21], facilitates the second half of our approach using constructionism and connectivism theories to support the foci of each worksheet, "From Questions to a Problem," and "From a Problem to Data Sources," respectively.

C. Implications for Engineering and Computer Education

Manifestations of the learning theories and frameworks presented in the previous section are evident in the worksheets designed for this work and are applicable to engineering and computer science education. Although presented in a way that suggest each worksheet is influenced by only one learning theory, actually, some, if not all worksheets have elements of the learning theories. We have highlighted the aspect of the theory most relevant to the research. Goel and Sharda [22] reported the kind of the activities that a typical engineering student is generally engaged in, do not help in enhancing creativity, critical thinking and innovative problem solving. It is clear that most of the activities students formally engage in as part of teaching-learning-evaluation process promote rote-learning and conformity rather than creativity, critical thinking and innovative problem solving." The worksheet method presented here includes creativity of thought, critical thinking and innovative problem solving. These concepts have been studied in engineering ([23] – [25]) and computer science; however, the proposed method introduces them in a different and engaging manner. The next section provides a summary of the worksheets and their expected outcomes.

III. Design Activity Worksheets

The first aim of the project was to introduce the activity worksheets for developing research questions to the graduate class. The concept for the worksheets is adapted from Chapters 3 and 4 of [6], and represented in a series of four worksheets. The goals, objectives and outcomes from each worksheet is presented in Table I. The first worksheet helps students to "Identify Topics," the second worksheet outlines how to develop "Topics into Questions," the third worksheet helps the student to transition from "Questions to Identify a Problem." In the fourth worksheet, the student will identify scholarly and acceptable "Data Sources." Upon completion of the worksheets, the content can be synthesized into a sound research question or, at a minimum, the student should be knowledgeable enough about the topic to have an informed conversation with his/her research mentor and/or instructor.

TABLE I. Goals, objectives and outcomes for activity worksheets

Worksheet	Goals	Objectives	Outcomes
Identifying Topics	Students will generate a list of three topics.	Students will list what they know and do not know about their self-identified topics.	Students will rank topics of interest and identify their target audience.
From Topics to Questions	Students will articulate what they hope to find out about the chosen topic.	Students will transition from a broad topic to a specific question.	Students will answer who/what/when/where and whether/why/how about their topic.
From Questions to a Problem	Students will develop a problem statement from the question posed in the previous worksheet.	Students will identify a problem their question will address.	Students will determine if the problem is a practical or conceptual problem and describe the significance of addressing the problem.
From a Problem to Data Sources	Students will learn about different types of data sources (primary, secondary, tertiary).	Students will identify appropriate data sources.	Students will plan, and determine the availability of data for the topic.

IV. Methodology

A. Study Design

To assess students' perception on the effectiveness of the proposed mechanism, a study was conducted in a graduate level seminar course at a research-intensive university in the Midwest United States in Fall 2019. The design activity worksheets were administered as part of the course.

The seminar is designed to assist new students as they begin their endeavors in graduate school, introduce the different aspects of the research process (e.g. literature review, data collection, writing, etc.), and facilitate the identification of areas of interest for the development of their thesis. The seminar is implemented as a forum for discussing ideas, research questions, and presenting proposals.

Students meet once a week during the 16-week semester. All students are required to take the seminar three times in different semesters. In any given semester, three student cohorts share the course experience by sitting in the same class and interacting with one another. This format facilitates a gradual delivery of relevant content and provides a venue to foster collaboration and mutual support among different student cohorts, who become mentors of new students as they advance in their graduate careers.

Upon completing the course, students are expected, at a minimum, for first year students, to have identified a research topic, identified the significance of the topic and articulate a problem statement and identify data to support the research topics. A total of 55 students enrolled in the 1-credit graduate seminar course in Fall 2019: 1st semester (20), 2nd semester (9) and 3rd semester (26); 49 students participated in the study. Participant characteristics are shown in Table II.

TABLE II. PARTICIPANT CHARACTERISTICS: NO. OF STUDENTS WHO COMPLETED THE WORKSHEET (%).

	Graduate Student Cohorts		
	1st Semester	***2nd Semester***	***3rd Semester***
No. Enrolled	20	9	26
Topics Worksheet	19 (39%)	7 (14%)	23 (47%)
Topics to Questions Worksheet	15 (33%)	7 (15%)	8 (19%)
Questions to a Problem Worksheet	17 (40%)	8 (19%)	18 (42%)
Problem to Data Source Worksheet	8 (32%)	5 (20%)	12 (48%)

B. Data Collection

The data for the project consists of the completed worksheets and students' self-assessment for the usability of the worksheets. Only the analysis of the students' perception data is provided here. Students were given one week to complete each worksheet. After completing each worksheet students were asked to provide feedback on their perception of the usability of the worksheet using a 5-point Likert scale: 1- Strongly disagree, 2- Disagree, 3-Neutral, 4-Agree, and 5-Strongly Agree. The number of questions for each assessment ranged from two to four questions. Each group of questions were specific to the worksheet completed. The sections below show the usability feedback statements for each worksheet.

a) Identifying Topics Assessment

1. I found the Topics Worksheet to be helpful in generating topics
2. The worksheet helped me to understand the relevance of the task of choosing a topic.
3. I had a clear idea of topics before completing the topics worksheet. The worksheet merely provided a mechanism for me to write topic ideas on paper.

b) From Topics to Questions Assessment

1. The worksheet helped me to identify the significance of the topic by helping me to articulate what I want to find out about the topic.
2. The worksheet helped me to identify the significance of the topic by helping me to articulate what I want to help my reader understand.

c) From Questions to a Problem Assessment

1. The worksheet helpedtoidentify the topic as a paractical or conceptual problem.
2. The worksheet helped me to understand what I want the reader TO DO after viewing the project deliverables.
3. The worksheet helped me to understand what I want the readers TO THINK after viewing the project deliverables.

d) From a Problem to Data Sources

1. The worksheet helped to identify primary data sources for the project topic.
2. The worksheet helped me to identify secondary data sources for the project topic.
3. The worksheet helped me toidentify tertiary data sources for the project topic.
4. The worksheet helped to assess if there are enough data sources and data for the project topic.

For each statement, if a student's response was "strongly disagree" or "disagree" they were asked to provide a brief explanation for their response. Students' qualitative feedback will inform evaluation and refinement of the Activity Worksheet Method for future class offerings. Analysis of students' qualitative responses is beyond the scope of this article.

C. Data Analysis

Analysis of the data aligns with the second aim of the project: to assess students' perception of the usability of the activity worksheet method in helping to identify students' research topics as practical or conceptual problem, explaining what they want the reader "to do" and "think" about the topic. For this work, only the student self-assessment data for the usability of worksheet are analyzed. Data analysis of Likert-scale data was performed. The mean is used as the basic descriptive statistical indicator for each statement in the survey research instrument. T-test calculations using two-tailed distribution, for two-sample unequal variance are used to compare Likert scores by sections and by questions. An alpha level of .05 was used to determine statistical significance. Contingency tables are generated to assess whether there is a correlation between semester cohorts and students' perception of the worksheet method. Chi-square tests of independence are performed to examine the relation between cohorts and students' perception of the usability of the worksheets.

V. Results

Contingency tables are calculated for each worksheet. The tables consist of two categories: graduate student cohort and the count for each Likert scale response (SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree), for each cohort.

TABLE III. Contingency table for "Identifying Topics" Worksheet (Question one and Question two)

Cohort	SD	D	N	A	SA	Total
1st Semester	0	2	10	24	2	38
2nd Semester	2	0	5	4	3	14
3rd Semester	3	3	20	16	4	46
Total	5	5	35	44	9	98

The third assessment question for the "Identifying Topics" worksheet is designed to assess if students felt they had a topic before completing the worksheet. The worksheet is then a mechanism for transferring their ideas to written form. The frequency responses were calculated separately and are shown in Table IV below.

Chi-square test of independence was performed on students' responses to assessment question three of the "Identifying Topics" worksheet to determine whether the level of a graduate cohort (first, second, or third) is related to students having existing topic ideas before completing the worksheet. The null hypothesis (H0) for this question is students have a clear idea of topics before completing the worksheet independent of graduate cohort level. The alternate hypothesis (H1), there is a relation between student graduate level and their knowledge of research topics before completing the worksheet. We found the relation between cohorts and their knowledge of topics before using the worksheet to be significant, X^2 (8, N=49) = 0.5409, p = 6.959. Since the critical Chi-square value (0.5409) is less than the test statistic (6.959) we reject the null hypothesis (H0) in favor of the alternate hypothesis, (H1) and conclude there is a relationship between cohort level and the knowledge of research topics before completing the "Identifying Topics" worksheet. As expected, the third-semester cohort indicated knowing what their research topics were before completing the worksheet.

For the remaining worksheets, Chi-square tests of independence were performed to examine the relation between cohorts and students' perception of the usability of each worksheet. The null hypothesis (H0) is students' perceptions of the usability of each worksheet are independent of graduate cohorts. The alternate hypothesis (H1) is students' perceptions of the usability of each worksheet are not independent of graduate cohorts.

A chi-square test of independence was performed using data in Table III to examine the relation between cohort level and students' perception of the usability of the "Identifying Topics worksheet. The relation between these variables was not significant, X^2 (8, N=98) = 14.68, p = .06, so we cannot conclude there is a relationship between cohort level and students' perception of the usability of the worksheet. However, the data in Table III (specifically 24 participants agreed) suggest, as a cohort, the first-semester students found the worksheet to be more helpful.

A chi-square test of independence was performed to determine the relation between graduate student cohorts and students' perception of the "From Topics to Questions" worksheet. The relation between the variables was found not to be significant, X^2 (8, N=98) = 11.72, p = .16. The data indicate the third-semester cohort found the "Topics to Questions" worksheet to be more helpful.

The relation between graduate student cohorts and students' perception of the "From Questions to a Problem" worksheet was examined using a chi-square test and was found to not be significant, X^2 (8, N=129) = 14.36, p = .07. The first-semester cohort responded more favorably, suggesting they found the "From Questions to a Problem" worksheet more helpful.

The relation between graduate student cohorts and students' perception of the "From a Problem to Data Sources" worksheet was found to be significant, X^2 (8, N=100) = 50.60, p = 3.13^{-08}. Since the critical value (p=3.13-08) is less than the confidence level (.05) the null hypothesis is accepted, there is a relationship between cohorts and students' perception of the usability of the worksheet. The data indicate 41% of the responses were "agree" and of those responses, the first-semester cohort found the "From a Problem to Data Sources" worksheet to be most helpful.

Fig. 2 shows cumulative response counts from all worksheets for each cohort. It is evident from Fig. 2 the most frequent response from each cohort was "agree."

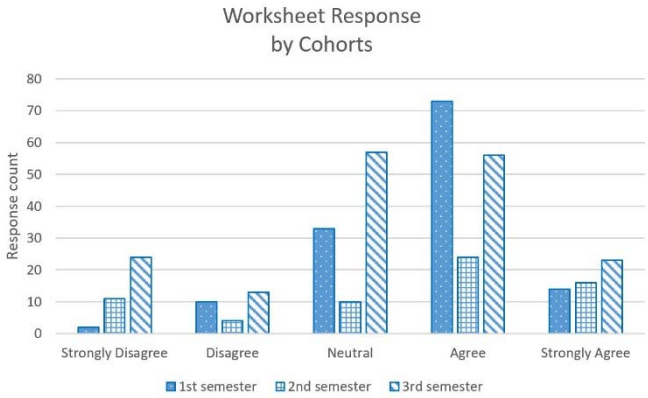

Fig. 2. Cumulative worksheet responses by cohorts.

In Fig. 3 we present the same data from Fig. 2 from a different perspective. A total of 370 responses were submitted. Fig. 3 graphically shows the third-semester cohort participated more frequently (173 total responses), followed by the first-semester cohort (132 responses) and a noticeable drop in participation from the second-semester cohort (65 responses). We acknowledge, the noticeable drop in participation could be indicative of the second-semester cohort size.

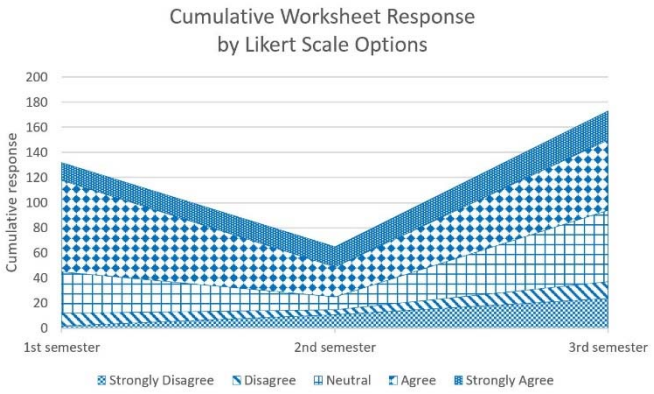

Fig. 3. Cumulative worksheet responses by Likert scale options.

VI. Discussion

The results of this research show graduate student cohort level impacts students' perception of the usability of the worksheet method. Each worksheet provides useful guidance for developing key elements of research questions. The data show the largest number of responses were received in response to the first worksheet "Identifying Topics." Participation noticeably decreased for the remaining worksheets. The worksheets are strategically named to reflect the activity and level of cognitive complexity required. Students tend to find the first worksheet to be an easy exercise; however, each subsequent worksheet requires more critical thinking and cognitive practice to complete. Students are not graded on their submissions, but given the outcomes will impact their future research, the expectation is that they will complete the worksheets in their entirety and submit the completed worksheets for feedback.

The worksheets are multi-purpose and can be used for individual, team based collaborative work. The worksheets have been utilized for class projects where students are asked to identify topics for individual and group semester projects. Although presented in the seminar course in a sequential manner, each worksheet is designed to stand alone, to be utilized during any stage of a research project or topic generation process. The adaptability of the worksheets enables wide-spread use. In addition to the graduate seminar course described here, the worksheets have also been used in an undergraduate course to help students develop topic ideas for semester projects. As a team assignment, each worksheet could be completed by group members either individually or collaboratively as a group.

A. Further implications for learning design

Our results provide indicators for opportunities for scaffolding the process. The worksheet method was developed after various approaches were implemented to engage students in the process of identifying and developing research topics. Previous approaches included, making and information available for students to assist with ways to identify and develop research questions, assigning related chapters and books [6], and providing online material. All of which, more often than not, resulted in lackluster research topics and minimal to no data to support topic ideas. When left as a self-directed exercise, students' results were superficial and lacked depth needed for a viable research topic supported by data.

Scaffolding can take many forms; one type of scaffolding is called process scaffolding, where a complex task, such as a research paper is broken down into smaller, more manageable parts [26]. Adams [3] describes scaffolded expectations and activities around the research process to motivate student engagement. The work presented in this paper utilized the Design Activity Worksheet Method as an individual task; however, a scaffolded activity, in future offerings, might include pairing students into working groups and asking them to work on specific tasks together so that they are accountable to another person and can co-problem solve any issues that arise [27]. This activity will facilitate near-peer collaboration and feedback before students share completed worksheets with the instructor and with their research professors (where applicable). The worksheet method presented in this work is an example of process scaffolding. It scaffolds four stages of the research process: identifying topics, developing questions from topics. further examining questions to identify and articulate a problem statement and identifying data sources to support the research statement.

The first-semester cohort seems to have perceived the worksheets, collectively, as being useful and the third-semester cohort found the second worksheet, "Topics to Questions," more helpful. The second-semester cohort responses, we suspect due to it small cohort size, tended to consistently fall between the level of responses for first and third semester cohorts, making it difficult to make any definite conclusions regarding the cohort's perception.

In future implementations of the assessment instrument we will expand the "Neutral" response to a more unambiguous response. Currently, it is unclear what is intended: "I don't know", "indifference," or if the student selected neutral by default.

VII. Conclusion

In this paper, we provided the theoretical background to support the use of a worksheet method as an educational tool for teaching and learning the process of developing research questions while fostering opportunities for critical thinking.

To address the decline in participation as more challenging worksheets are assigned, in the future, the worksheets will be triangulated between the student, the instructor of the graduate seminar and the faculty researcher the student identifies as their primary research advisor. This step will serve three purposes: 1) motivate students to complete the worksheets, 2) provide feedback to students' primary research advisor regarding how well the student understands the focus of the research. This will also encourage conversation between the student and research advisor at a critical turning point in the graduate student's research plan. Lastly, the triangulation will foster communication between faculty researchers as to the validity of the worksheets (i.e., does the worksheets capture what they feel their students should understand about their research topic?) and provide feedback on how to refine the worksheet.

Additionally, the current set of worksheets is limiting for students interested in qualitative research. To address this challenge, we will explore the development of another similar

set of worksheets to accommodate the development of qualitative research questions.

Although we are encouraged by the outcomes, we acknowledge the work is not without limitations. The first limitation is the relatively small sample size. Fall 2019 was the first semester the worksheets were utilized as a tool for graduate students' development of research questions. We anticipate more participants with each offering of the graduate course and refinement of the worksheets.

Regarding the main research questions of this paper ("at what point is the worksheet method most effective and when should the worksheets be introduced?"), our results suggest the worksheets are useful at all stages of the process; however, most effective in the early semesters when new graduate students are at the stage of defining their research questions. The worksheets are also helpful in later stages as the scope of the research is refined and further developed. The applicability of the discipline agnostic worksheets is far reaching. The worksheets can be used in any setting where the development of a research question is desired, for example, the development of topics for class assignments, semester long projects (for example, capstone projects), and independent study projects, to name a few.

ACKNOWLEDGMENT

We acknowledge the participation of the students who participated in this study.

REFERENCES

[1] F. Trede, and J. Higgs, "Framing research questions and writing philosophically: The role of framing research questions. In Writing qualitative research on practice, Brill Sense, 2009, pp. 13-25.

[2] G. Hughes, "Developing student research capability for a 'post-truth'world: three challenges for integrating research across taught programmes." Teaching in Higher Education, 2019, vol. 24, no. 3, pp. 394-411.

[3] S. K. Adams, "Empowering and Motivating Undergraduate Students Through the Process of Developing Publishable Research," Frontiers in Psychology, 2019, vol. 10, pp. 1007, May 2019.

[4] D. M. Torre, B. J. Daley, J. L. Sebastian, and D. M. Elnicki, Overview of current learning theories for medical educators. The American journal of medicine, 119(10), 2006, 903-907.

[5] Grippin P, Peters S.Leaning Theory and Outcomes. Lanham,MD: University Press of America, 1984.

[6] W. C. Booth, G. Gregory, J. M. Colomb, J. M. Williams, J. Bizup, and W. T. FitzGerald, The Craft of Research. Fourth ed. Chicago Guides to Writing, Editing, and Publishing, 2016.

[7] R. Paul, and L. Elder, The miniature guide to critical thinking concepts and tools. Rowman & Littlefield, 2019.

[8] A. L. Costa, and B. Kallick, (Eds.), Learning and leading with habits of mind: 16 essential characteristics for success. Alexandria, VA: Association for Supervision and Curriculum Development, 2008.

[9] S. Altan, J. F. Lane, and E. Dottin, "Using habits of mind, intelligent behaviors, and educational theories to create a conceptual framework for developing effective teaching dispositions," Journal of Teacher Education, vol. 70, no. 2, 2019, 169-183.

[10] R. Kop, and A. Hill, "Connectivism: Learning theory of the future or vestige of the past?," The International Review of Research in Open and Distributed Learning, vol. 9, no. 3, 2008.

[11] R. H. Bruning, G. J. Schraw, M. M. Norby, and R. R. Ronning, Cognitive psychology and instruction (4th ed.). Upper Saddle River, NJ: Merrill/Prentice Hall, 2004.

[12] D. Moshman, "Exogenous, endogenous, and dialectical constructivism," Developmental Review, vol. 2, 1982, pp. 371–384.

[13] D. C. Phillips, "The good, the bad, and the ugly: The many faces of constructivism," Educational Researcher, 24(7), 1995, pp. 5–12.

[14] D. H. Schunk, Learning theories an educational perspective sixth edition. Pearson, 2012.

[15] C. Kalina, and K. C. Powell, "Cognitive and social constructivism: Developing tools for an effective classroom," Education, vol. 130, no. 2, 2009, pp. 241-250.

[16] J. Mattar, "Constructivism and connectivism in education technology: Active, situated, authentic, experiential, and anchored learning," RIED. Revista Iberoamericana de Educación a Distancia, vol. 21, no. 2, 2018.

[17] M. Pedaste, M. Mäeots, L. A. Siiman, T. D. Jong, et al., "Phases of Inquiry-based Learning: Definitions and the Inquiry Cycle," Educational Research Review, vol. 14.C, 2015, pp. 47-61.

[18] N. Sansone, and D. Cesareni, "Which Learning Analytics for a socio-constructivist teaching and learning blended experience?," Journal of e-Learning and Knowledge Society, vol. 15, no. 3, 2019, pp. 319-329.

[19] A. K. Ahmed, (2013). Teacher-centered versus learner-centered teaching style. Journal of Global Business Management, vol. 9, no. 1, 2013, pp. 22.

[20] M. Scardamalia and C. Bereiter, "Knowledge building, theory, pedagogy, and technology," in The Cambridge Handbook of the Learning Sciences, R.K. Sawyer (Ed). Second edition, 2014, Print.Cambridge Handbooks in Psychology.

[21] Y. An and D. Mindrila,"Strategies and tools used for learner-centered instruction," International Journal of Technologyin Education and Science (IJTES), vol. 4, no. 2, 2020, pp. 133-143.

[22] S. Goel, and S. Nalin, "What do engineers want? Examining engineering education through Bloom's taxonomy," 15th Annual Conference for the Australasian Association for Engineering Education, AaeE 2004, 27th - 29th September 2004, Toowoomba, Queensland, Australia.

[23] S. Sasidhar, "Enhancing Critical Thinking in Engineering by Incorporating an E-assignment and Peer Review in a Blended Learning Course." In 2019 IEEE Frontiers in Education Conference (FIE), pp. 76, October 2019.

[24] M. Hu, S. Cleland, and S. Burt, "Build up a Constructivist Learning Environment for Teaching First-year Students Data Flow Diagrams." In 2019 IEEE Frontiers in Education Conference (FIE), pp. 67, October 2019.

[25] J. Kastner, and H. Cheng, "Developing Critical Information Literacy in First-Year Engineering Students." In 2019 IEEE Frontiers in Education Conference (FIE), pp. 64, October 2019.

[26] Columbia College, Designing Research Assignment: Scaffolding Research Assignments." URL: https://columbiacollege-ca.libguides.com/designing_assignments/scaffolding Last accessed June 21, 2020.

[27] O. J. Shanahan, E. Ackley-Holbrook, E. Hall, K. Stewart, and H. Walkington, "Ten salient practices of undergraduate research mentors: a review of the literature Mentor. Tutor, vol. 23, 2015, pp. 359–376. doi: 10.1080/13611267.2015.1126162