

## The Nature of Undergraduate Students' Conceptions of Inquiry

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### Abstract

The purpose of this study was to investigate undergraduate students' conceptions of inquiry. Data were obtained from 212 undergraduates using an open ended questionnaire which required them to define inquiry and explain its importance. Analysis of the participants' definitions using open coding and constant comparison yielded 13 categories of inquiry conceptions. Closer examination of the derived categories indicated that they could be grouped into three superordinate categories of inquiry as: *a learning process*, *an instructional process*, and *a research/scientific process*. Observation of the prevalence of categories revealed *inquiry as a learning process* as the most prevalent and *inquiry as a research/scientific process* as the least prevalent superordinate categories. Particularly, the presence of *inquiry as a means of gaining information/knowledge* as the most prevalent conception implies that more work is needed to help students develop conceptions that can stimulate productive engagement in inquiry.

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### Introduction

Conceptions refer to individuals' ways of theorizing, hypothesizing, and thinking about almost every aspect of the perceived world (Entwistle, 2007; Gilbert & Watts, 1983; Pratt, 1992). They are representations of a phenomenon as experienced and understood by individuals (Dahlin, 2007; Marton, 1981; Marton, Dall'Alba, & Beaty, 1993). Conceptions involve cognitive endeavors that lead to the formation of underlying organizing frames, understandings, meanings, and mental representations of objects, phenomena, or concepts (Andrews & Hatch, 2000;

Larsson & Halldén, 2010; Pratt, 1992). Simply put, our conception of something represents our actual understanding of that thing.

Much of the educational research on this topic has addressed conceptions of *learning*, and *teaching*. Conceptions of learning pertain to “variations in students’ explanations of their experiences of learning” (Schmeck, 1988, p. 3). They denote a “system of knowledge and beliefs about oneself as a learner, learning objectives, learning activities and strategies, learning tasks, learning and studying in general” (Vermunt & Vermetten, 2004, p. 362). *Conceptions of teaching* denote the ways by which the instructional process and the roles teachers assume in the process are understood; they depict preferred ways of teaching and the overall view of the instructional process (Chan & Elliott, 2004; Kember, 1997).

The value of studying conceptions is seen in their relationship to individuals’ behaviors or actions. Empirical evidence shows that students’ conceptions of learning strongly influence their approaches to learning. More specifically, students who view learning as merely increasing of one’s knowledge (i.e., quantitative gain) mostly adopt surface approaches to learning whereas those who view learning as a process of understanding and conceptual change (i.e., qualitative gain) tend to employ deep strategies to learning (e.g. Chiou, Liang, & Tsai, 2012; Dart et al., 2000; Edmunds & Richardson, 2009). Similarly, teaching conceptions influence teachers’ actions. For instance, Trigwell and Prosser (1996) observed a significant relationship between conceptual change intention (conception) of teaching and the use of student-focused teaching strategies as well as between information transmission intention (conception) of teaching and teacher-focused teaching strategies. Kember and Kwan (2000) observed a similar relationship between the conception of teaching as transmission of knowledge and the use of content-centered teaching approach, and between the conception of teaching as facilitation of learning and the use of learning-centered teaching approach. A more contextualized relationship between conceptions and practices was also established by Atar and Gallard (2011). They examined the relation between Nature of Science conceptions of practicing teachers who were attending a science-education master’s program and their planning and practicing of inquiry in the classroom. The results indicated that teachers with more sophisticated conceptions tend to plan and practice inquires that are less structured. In general, these studies support the validity of Pratt’s claim that there is “a logical connection between our conceptions and our actions...conceptions act as mediating influences on the ways in which we perceive and interpret the stimulus situation and, as a result, the course of action we choose to take” (Pratt, 1992, p. 306).

Inquiry is a multifaceted concept which has no single agreed-upon definition (Anderson, 2002; Aulls & Shore, 2008). It is easier to agree on what inquiry is not rather than what it is (DuVall, 2001; Minstrell, 2000). In spite of different definitions, inquiry has been advocated in curricular reform reports and various studies for more than three decades and since then school reforms and standards have expected inquiry to be integrated in the regular curriculum (Aulls & Shore, 2008). Inquiry helps learners become active, efficient problem solvers and critical thinkers who can effectively apply their knowledge (Manconi, Aulls, & Shore, 2008). However, inquiry has to be well understood before it is supported and implemented successfully as a form of classroom instruction. A first step to this end is to develop a solid understanding of conceptions students have about inquiry. On the basis of the claims discussed earlier about the

role conceptions play in students' learning and teachers' practices, it seems logical to hypothesize that the ways students conceptualize inquiry can influence their engagement in inquiry. Individuals' understandings of a phenomenon mediate the quality of their engagement in processes involving the phenomenon (Meyer, Shanahan, & Laugksch, 2005). This makes the study of students' *conceptions of inquiry* worthwhile.

Further justification for studying conceptions of inquiry lies in the need to examine conceptions in a more contextualized manner. Context not only plays an important role in students' learning (Van Oers, 1998) but it also influences students' perceptions of good and poor teaching (Aulls, 2004). Therefore, beyond an overall focus of examining learning and teaching conceptions, more specified and contextualized examination of conceptions is believed to be of paramount importance for improving practice. Eley (2006) affirms that the functional influence of conceptions on practice will be more evident when conceptions are examined in a more specific and contextualized manner. It follows that knowing the ways by which specific approaches, such as inquiry, are conceptualized will be helpful to think about more directed and contextualized measures to take so as to get the best out of these approaches. This study was undertaken to shed light on some of the assumptions stated above. Specifically, it investigated the ways in which undergraduate students conceptualize inquiry. The research question the study has addressed was: *what conceptualizations do undergraduate students hold about inquiry and how prevalent are the conceptions?*

### **Conceptualizing of Inquiry in the Literature**

From the education literature in general and science education literature in particular, one can discern that inquiry has been conceptualized: (a) as a broad scientific or research process, (b) as content or the subject of learning, (c) as the process of learning, and (d) as the process of instruction.

As a broad scientific or research process, inquiry can be viewed as a way of generating knowledge or engaging in scientific endeavors. Scientists study the natural world, answer questions that interest them, and offer viable explanations for phenomena or problems at hand (Germann, Haskins, & Auls, 1996; Karaman, 2007; Lederman, 1998; National Research Council, 1996). Inquiry, from this angle, is considered as the work scientists do (Chinn & Malhotra, 2002; Harwood, Reiff, & Phillipson, 2002; Martin-Hansen, 2002) as well as the activities in which individuals are engaged when they do science (Germann et al., 1996). It can also denote philosophical positions or world views that govern the methods and procedures researchers employ in doing research and solving problems, labeled as *frames of inquiry* by Butler (2006).

Inquiry can also be conceptualized as the content of learning. Thus, it can be taught explicitly as a topic of instruction (Flick, 1995) or students can implicitly acquire an understanding of the nature of inquiry as a result of engagement in the process (e.g., Wang & Lin, 2008). In either case, inquiry is conceived as content to be learned. Expanding this notion further, Minstrell (2000) discusses three kinds of learning connected to inquiry: *learning about inquiry*, *learning to do inquiry*, and *learning by inquiry*. The first corresponds with content of learning. It has more to do with learning about scientists and how they developed scientific

knowledge (Lederman & Flick, 2002; Minstrell, 2000) as well as exploring the nature and frontiers of research in the discipline they are pursuing (Healey & Jenkins, 2009). Such learning can be achieved implicitly from active engagement in the process (Akgul, 2006; Wang & Lin, 2008; Wee, Shepardson, Fast, & Harbor, 2007) or explicitly from treatment of inquiry as a course of study (Houlden, Raja, Collier, Clark, & Waugh, 2004; Justice et al., 2007).

Inquiry as a learning process, on the other hand, engages students in an inquiry task rather than the task being done for them. The experience is believed to enhance their knowledge (Anderson, 2002; National Research Council, 1996). “It is an active mental process that demands the active participation of the learner” (Anderson, 2002, p. 2). At the most student-directed level, inquiry learning begins with students’ generation of questions to be answered, problems to be solved, or a set of observations to be explained (Prince & Felder, 2006). Emphasis is on meaning making, critical thinking and reflection, constantly questioning knowledge and experiences, seeking appropriate solutions, understanding concepts and principles which guide student generated investigations rather than finding right answers and memorizing facts (Atar, 2007; Windschitl, 2004). Hence, it is viewed as a form of self-directed learning which makes students become more responsible for determining what they need to learn, for identifying and using resources and how best to learn from them, for assessing their progress in learning as well as for reporting their learning (Henson, 1986; Martin-Hansen, 2002; Roy, Kustra, & Borin, 2003).

Finally, inquiry as a form of instruction pertains to the way in which a teacher sets the environment so that inquiry learning can be promoted. Prince and Felder (2006) portrayed inquiry as “instruction that uses questions and problems to provide contexts for learning” (p.5). As an instructional process, it involves creating effective learning environments that “provide an active setting for students with essential scaffolding based on each student's readiness and current ability” (Marshall & Horton, 2011, p. 93). Using open-ended questions that instigate investigations, making activities student-centered, allowing students to have more alternatives as well as modeling the general processes of investigations scientists use are important features of inquiry-based instruction (Barrow, 2006; Beyer, 1971; Demir & Abell, 2010).

### **Studies on Undergraduate Students’ Understandings of Inquiry**

In the wider educational literature, the most commonly addressed conceptions are those of learning and teaching. An explicit focus on conceptions directed towards a specific phenomenon related to learning or teaching in general, and inquiry learning and instruction in particular, is scarce in the literature. A scrutiny of relevant empirical studies shows that undergraduate students’ understandings of inquiry are addressed in one or more of the following three ways: (a) examination of the conceptual understandings students developed about inquiry from inquiry-based learning experiences (Aulls & Ibrahim, 2012; Demir & Abell, 2010; Eastwood, Sadler, Sherwood, & Schlegel, 2012; Windschitl, 2000), (b) examination of the changes in students’ understanding of inquiry after learning about inquiry and/or experiencing inquiry-based instruction (Haefner & Zembal-Saul, 2004; Hook, Huziak-Clark, Nurnberger-Haag, & Ballone-Duran, 2009; Lotter, Singer, & Godley, 2009; Varma, Volkmann, & Hanuscin, 2009; Wang & Lin, 2008), and (c) examination of students’ attitudes and reflections after experiencing inquiry-based instruction (Duran, McArthur, & Hook, 2004; Hayes, 2002; Kim & Chin, 2011; Morrison, 2008; Qablan, Al-Ruz, Theodora, & Al-Momani, 2009) which mirrors their concerns about inquiry-based learning and instruction. In most cases, students’

understandings of inquiry were investigated before and/or after intentional and explicit exposures to inquiry-based experiences.

Studies in the first category have examined the ways in which students make sense of their inquiry experiences and represent the nature and characteristics or processes involved in inquiry-based approaches. In a study by Windschitl (2000) three ways of representing the inquiry process emerged after a sample of twelve pre-service teachers took part in an independent inquiry experience and were asked to depict how they had gone through the process: *inquiry as a linear process characterized by discrete tasks and a stepwise movements*, *inquiry as a bi-directional process characterized by regular testing and adjustment of earlier phases*, and *inquiry as a process in which different phases “only make sense in relation to one another and that phases have to be considered simultaneously at the outset of the inquiry”* (p. 11).

In another study by Demir and Abell (2010), four beginning teachers and two science methods-course instructors were asked to explain what teaching science through inquiry means to them, what inquiry learning would look like in their classes, what constraints, if any, they encountered for implementing inquiry-based activities in teaching, and what they think their students learn about science while involved in inquiry-based activities. Analysis of data from interview questions, class observations of teaching, and field notes for the four beginning teachers revealed that they conceptualized inquiry as: (a) a process of problem solving that relies on initiative of students, (b) an endeavor that relies on teacher's guidance, and (c) discovery learning. Examination of these conceptions relative to the five essential features of inquiry described by the National Research Council (2000) suggests that such conceptions represent incomplete views of inquiry. The importance of evidence, formulating explanations based on evidence, connecting explanations to scientific knowledge, and communicating explanations were missing in the participants' understandings of inquiry.

The second category of studies examined the extent to which students' understandings of inquiry changed as a result of instruction that was inquiry-based or instruction that had an explicit focus on inquiry as a content of learning. The results from these studies indicated that students' understandings of inquiry tended to be more complex after engaging in inquiry-oriented tasks and/or learning about inquiry. Comparison of students' understandings of inquiry under pre- and post-inquiry based learning experiences revealed that initially only a small proportion of students revealed informed understandings about inquiry. However, post-inquiry-based experience understandings did not only reveal better proportion of students to display informed understandings but broader or multidimensional representations of inquiry were also evident (Haefner & Zembal-Saul, 2004; Hook et al., 2009; Wang & Lin, 2008).

The third way in which students' understandings of inquiry has been studied is through the examination of attitudes and concerns students reflected following inquiry-based learning and instruction experiences. Studies in this cluster indicate that students tend to think that inquiry is impractical and unrealistic in school classrooms as there are all sorts of factors affecting its implementation. There is a tendency to understand inquiry as a difficult endeavor due to problems of knowing the scope of one's roles (Hayes, 2002), association of inquiry to too much workload and demanding preparation (Duran et al., 2004; Hayes, 2002), as well as concern about

classroom management (Roehrig & Luft, 2004). Such concerns may inadvertently overshadow students' perception of inquiry as a worthwhile endeavor for better understanding of content and may make them feel uncomfortable to learn through inquiry (Qablan et al., 2009).

## Method

### Participants

Two hundred twelve undergraduate students (166=female; 46=male) from two universities in eastern Canada and one university from northeastern USA participated in this study. The participants were from 26 professors' classrooms who themselves were randomly selected for a research project on inquiry teaching and learning in higher education. The participants completed the questionnaire on a voluntary basis. They represented various disciplines mainly from teacher education and science-related programs. In terms of their years of studies, 103 were in their first, 45 in their second, 31 in their third, 19 in their fourth, and 9 in their fifth year of studies. Five participants either did not report or provided unclear data about their year of studies.

### Instruments

An open-ended questionnaire was used for data collection. The participants were asked to write their own definition of inquiry and explain its importance, to imagine and describe a classroom scenario in which the teacher and students engaged in good teaching and learning, to explain whether they have experienced such a classroom and to specify the level at which they had such an experience. For this study, only responses obtained to the question that asked the students to define inquiry and explain its importance were used.

### Data Analysis Procedure

As a first step, significant idea units that mainly depicted the goals and/or processes of inquiry mentioned in the definitions were identified. The idea units were then coded, using open coding and constant comparison (Strauss & Corbin, 1998). Initial inter-coder reliability (on about 20% randomly selected definitions) between two independent coders, the first author and one of the co-authors, was 81% before any discussions. Once the categories were further elaborated through thorough discussion, another round of reliability checking took place, yielding 92% agreement before discussion. This coding scheme was then used to code the remainder of the data.

## Results

### Conceptions of Inquiry

Open coding and constant comparison of significant idea units obtained from the participants' definitions of inquiry and explanations of its importance yielded 13 categories of inquiry conceptions. Closer examination of the derived categories indicated that they could be grouped into three superordinate conceptual categories by which undergraduate students conceptualize inquiry: *inquiry as a learning process*, *inquiry as an instructional process*, and *inquiry as a research/scientific process*. These categories corresponded with those cited in the literature review. Repeated constant comparison of the complete set of definitions was conducted to assure all student definitions of inquiry were accounted for by the primarily in vivo and low inference subcategories as well as by the broader researcher generated superordinate conceptual

categories. Following is an elaboration of the superordinate and subordinate categories and excerpts from the participants' responses as exemplars.

### **Inquiry as a Learning Process**

This denotes representation of inquiry as an endeavor by a student, an individual, and/or a group of students in order to learn something including the accompanying processes that the learning involves. The focal subjects of the inquiry definitions under this superordinate category were "individual learners" or "group of learners." The kind of learning depicted ranged from "simple acquisition of information" to "the construction of meaning for oneself." Of the 13 subordinate categories, three of them represented inquiry as a learning process: inquiry as a way of *gaining information/knowledge*, *developing knowledge*, and *self-learning & knowledge construction*.

**Gaining information/knowledge.** Inquiry in this subcategory was conceptualized as a means of seeking information or knowledge and subsequently of answers, solutions or truth. As part of seeking information, individuals ask questions or make inquiries about a situation or an event they are interested in. In such a conceptualization, inquiry corresponds with the curiosity for acquisition of facts or details about something or an event as part of everyday life experience. The following excerpts represent inquiry as asking to know a process or something factual.

*Inquiry is the action result of ignorance. When someone does not know a certain process, such as, how to use an electric composter, they make an inquiry as to how it is used. An inquiry is made when a base of knowledge is sought in order to perform some task....* (530)<sup>1</sup>

*...inquiry is to ask question in the purpose of collecting data. Ex. to inquire over someone's age.* (212)

In the course of obtaining the information, active engagement of the information gatherer, detailed questioning, and raising relevant questions appeared to be essential.

*Inquiry is asking questions ... to obtain information from an individual ... the information-gatherer plays an active and integral role in obtaining information. And, the information gathered is only as detailed and relevant as the questions ask[ed], thus the information-gather must ask the correct questions.* (320)

Beyond the gathering of information that aims at satisfying personal curiosity, inquiry was also represented broadly as a means of obtaining knowledge. No explicit ways of obtaining the knowledge were emphasized. In this regard, we find definitions such as the following: "Inquiry would be the seeking of knowledge through various means. It is important as it is the starting point of learning" (102) and "in my opinion inquiry is how a student gains knowledge no matter how it is they learn" (312).

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<sup>1</sup> The numbers in parentheses represent participants' codes

Both seeking of information and obtaining knowledge seem to be the means of arriving at a truth or final solution to a problem. Though it is not explicit what the participants mean by truth, it is possible to assume that they perceived inquiry as a means of obtaining what can be seen in the end as true and/or correct or a definite solution pertaining to a problem.

*Inquiry: When you are seeking information. You are looking for the truth. It is important, especially for this, because in surveys you want people to be truthful so that you get good information. (606)*

*Inquiry is questioning.... it is how we come to have an understanding of the world around us and obtain answers to our questions. (602)*

**Developing knowledge.** In this subcategory, inquiry was conceived as a means of furthering one's understanding. Individuals tended to question, or even engage in conducting research to better understand what they already knew. Inquiry was typically described as the tendency to know more or learn more. This is not the same as merely searching for information; it rather denotes going beyond what one has already acquired and places emphasis on the deepening of understanding. It also can involve looking for clarification of whatever is perceived to be difficult as elucidated in the following excerpts:

*...inquiry involves asking questions in order to clear up a matter that maybe confusing. I think this is important and should be encouraged as it provides all the students in the class the opportunity to clear up difficult points or reinforce important concepts in some cases. (80)*

*To my understanding, it might refer to students seeking out their professors after, during class to ask for clarifications on topics previously discussed in the school/classroom setting clarifications on such things as examples, from assignments, etc. (365)*

Inquiry as a means of developing knowledge was also exhibited in terms of the tendency to know better, to shape learning in accordance with one's personal interest as well as to look at things from a different angle. These aspects are depicted in the following excerpts:

*Inquiring is to question something that you don't understand. The importance of it is to have gain[ed] better knowledge of something that you are inquiring about. (20)*

*Inquiry is when one asks questions. It is important because it shows what one wants to know so he/she can personalize his/her learning experience and expand his/her knowledge in the directions of his/her personal interests and curiosities. (215)*

*Reinforcement of learned principle through the exploration of many angles/approaches to that idea. As a science major, this involves the practical application of ideas in the laboratory as well as seeing how topics are connected with each other (often in unexpected ways). (362)*

**Self-learning & knowledge construction.** In this subcategory, the learner or individual was placed at the center of independent learning and active construction of knowledge or understanding. The importance of the learners' prior knowledge and the taking of responsibility for their own learning were emphasized.

*Inquiry is the process through which a learner explores a topic about which they may have little or no prior knowledge. It allows them to construct their knowledge about a concept into something meaningful to them by asking questions and experimenting rather than being told what to know. (253)*

*It [inquiry] allows students to construct their own understanding of concepts and make relevant links to what they know. Inquiry is important to education because it allows students to think critically about their education while also making learning more interesting and relevant to their lives. (228)*

*Inquiry learning is an innovative approach to education.... Inquiry learning recognizes the fact that individuals have pre-knowledge and they learn best when they are empowered and take responsibility for their own learning process. (470)*

Different patterns of participation in constructing one's own understanding were represented in the definitions. Students commented that they could engage in such construction independently and/or collaboratively with others.

*I believe that the inquiry approach is about discovering for yourself and with others what the subject is about, by discussing together and working together towards finding out the answers yourself. (537)*

*Inquiry – Arriving at knowledge by asking a series of questions and trying to find the answers independently or with some guidance. It is important because “finding out” is a more engaging way of learning than “being told”. (273)*

The outcome of the self-learning could also extend beyond finding out answers or results and could be extended to the learning of the process of exploring and asking questions.

*Inquiry is a physical manifestation of curiosity. It allows students to pursue knowledge about the world around them [by themselves]. Inquiry is less concerned with results and focuses instead on the act of exploring and asking questions. (303)*

### **Inquiry as an Instructional Process**

Here, the focus was on the conceptualization of inquiry as a classroom endeavor by teachers and the accompanying instructional processes. It was mainly conceived in relation to school or classroom settings. What a classroom instruction involving inquiry looks like, its elements, and the goals it tends to address were the foci of this conceptualization. There were five subcategories representing inquiry as an instructional process.

**An adaptive form of teaching.** Under this subcategory, inquiry was represented as a form of teaching aimed at addressing different types of students. On the one hand, there was emphasis on the need of understanding students' levels of ability and motivation; on the other hand, there was an effort to fit the curriculum, lessons and materials, and to use a variety of methods so as to address individual differences.

*I think that inquiry is a way of learning when teachers understand their students' level; there are different ways and approaches to help them learn. Inquiry is about asking the right questions about how to better fit the curriculum to your students so they can learn more effectively. (195)*

*Inquiry: being responsive to the real motivations of the students, understanding the motivations and be able to connect a student's potential to the teacher's teaching material. (420)*

*I believe that it is teaching ... using a variety of different methods.... It is a way of acknowledging that any given class of students could be made up of individuals who learn in very different ways - some may prefer to be lectured at - some may prefer to have minimal instruction then read around the subject themselves - some may prefer to "do". By the same token, no two teachers will have the same teaching style - like the students, they may prefer to lecture or may prefer activity based teaching. (559)*

**A tool for assessment.** Under this subcategory, inquiry was conceived as a means of assessing students' levels, probing their thinking, and reflecting upon one's own practice. One purpose of the assessment was described as getting information about what students already know and their prior learning experiences before starting to teach a subject.

*Inquiry ...would have something to do with asking the students what they know about a subject before actually beginning to teach them about it. That way, they [teachers] realize the knowledge they [students] already have.... (114)*

*Inquiry is a way to assess students by asking them various questions and trying to learn more about their learning experience.... (104)*

Furthermore, inquiry was conceived as a formative means of assessment. In this sense, it was seen as helpful for monitoring students' progress as well as one's own practice to get feedback about weaknesses and strengths so as to make teaching more efficient.

*I think the definition of inquiry is to question. The method is important as through questioning educators may gauge their students' progress. They may also learn where their students' strengths and weaknesses lies, as well as other relevant information. (229)*

*.... with the help of inquiry, the tutors could explain the knowledge where students are confused, which can make the lecture highly efficient. Moreover, the teacher could know*

*which part can attract students' attention. To conclude, inquiry could assist teachers to know the key points for students to learn (328)*

*Inquiry is always questioning what and how you teach in the classroom.... It is important because you are always looking to improve your teaching to benefit the students. (173)*

As a tool of assessment, inquiry was also conceived as asking questions in order to probe students' thinking so as to find out what ideas were they entertaining in their minds.

*Inquiry to me is the science of asking questions, and the ability to ask them in ways that provoke well-thought-out answers. It is probing to find out how one thinks or to discover ideas that one has in their head. (299)*

*Inquiry is an investigation to students.... It really is a method for teacher to understand how students think.... (328)*

**A means of empowering students.** Here, emphasis was given to the role teachers play in helping learners become self-driven, in triggering curiosity among students, and in giving encouragement to students to think, observe and investigate by themselves. Teachers set the instructional context for learners to engage in thinking and reasoning to arrive at conclusions.

*[Inquiry is] to guide students to reflect by asking them questions; empowering them to not only think and reason, but to come to their own conclusions through observation, reflection and justify their conclusions by reasoning. (603)*

*I believe it's by giving the students many chances to think for themselves, and asking the open-ended questions. I also believe it [inquiry] involves having students research on many topics. (515)*

**Teaching for in-depth understanding.** Here, inquiry was seen as a way of teaching that helps students so that they “will actually remember and understand” what they have learned. It was conceived as a way of teaching different from lecturing (information transmission), to be enacted when students do not have enough knowledge about the subject. It was also seen as keeping students concentrated and helping them to critically consider the subject matter. This perspective necessarily placed the teacher in a more dominant role and did not provide an explicit elaboration of the activities undertaken by students.

*Inquiry teaching is when you want to teach your students about a subject that they may not have too much knowledge in .... (69)*

*When students are lectured, they may drift off and lose concentration on the subject. By involving students, it [inquiry] allows for elaboration and a visual, conceptual understanding of material, it is extremely important to allow children to learn in a manner where they will actually remember and understand the material. (85)*

**An active/interactive form of teaching.** Here, inquiry was conceived as a form of teaching, characterized by active engagement and interaction between and among students and the classroom teacher. The presence of dual relationship between teachers and students, and mutual asking and answering of questions by teachers and students as well as student centeredness of teaching were features mentioned in describing inquiry as an active/interactive form of teaching.

*The process of inquiry is a dual process between the teacher and student.... (56)*

*Inquiry instruction is ... where teacher and students test, experiment and come to conclusions about a subject or as research together as a learning experience. (83)*

Interactions were seen as generated through asking and answering questions, originating from the teacher or the students, and aimed at driving independent reflection and group discussion.

*I would guess that it's a teacher asking various questions to the students throughout the lecture and the students themselves asking questions to teachers and other classmates.... (396)*

*...it [inquiry teaching] is the professor encouraging the students to ask questions to open a discussion about interesting, confusing or important course topics. (62)*

*Inquiry is a question-based, student-centered teaching method. Rather than imparting information at the front of the class, teachers act more like facilitators. (82)*

Differentiation of the levels of questioning was observed in the participants' definitions: lower level (closed ended) versus higher level questioning and a preference was seen for the latter type of questioning. Questions were set to guide discussions and encourage independent or group reflection.

*The inquiry approach in a classroom involves questioning the students - that is lower-level and higher level questioning. This can be a situation where the teacher delivers a discussion question to the class and the students reflect on it independently or in groups. it is also important to encourage students to reflect on their own question (245)*

*It [inquiry] involves the back-and-forth asking of high-level questions (i.e.: not "yes" or "no" answers). (56)*

### **Inquiry as a Research/Scientific Process**

This superordinate category included five subcategories which described inquiry as an endeavor by a researcher or a scientist. Participants' definitions were focused on broader goals and processes that tend to require some expertise beyond what an inexperienced individual learner could possess. Responses indicated that inquiry was seen as involving logic, deduction, rational steps, doing experimentation, surveys, research projects, and rigorous testing, all of

which require some level of expertise on the part of those involved. The following are the five subcategories within this superordinate category.

**Problem solving.** Here, inquiry was conceptualized as the ability to comprehend problems, to use logic and deduction, and to undertake rational steps so as to resolve problems and issues regardless of discipline or field of study.

*Inquiry is the ability or act of using research, logic, deduction and other means to resolve problems and issues. It can be used in almost any field, e.g., medicine, science, languages. (342)*

*My personal definition of inquiry is the ability to comprehend a problem and to recognize how to solve it. Inquiry is also the ability to think about the problem at hand and to make decisive and rational steps as to how to solve it.... (360)*

**Hypothesis testing/hypothesizing.** Here, inquiry was equated with hypothesizing and proving of hypotheses. Experimentation with controlled variables as well as the examination of primary and secondary data sources were conceived useful in order to prove the hypotheses which could pertain to natural or historical phenomena.

*An example of an inquiry using the scientific method would include trying to prove a hypothesis by doing experimentation with controlled variables. An inquiry that might be historical in nature would involve looking at primary and secondary sources of accepted validity to the answer to a historical question or hypothesis. The point of an inquiry would be to be able to prove something with solid parts or proofs. (8)*

*Inquiry is when you are thinking about what is going on before you do your research and begin a project. it is the initial thought or hypothesis. this is important because then you get to think about what is going to happen and why. (547)*

**Researching for understanding.** Here, inquiry as a research process was represented in terms of its value to better understand an event or a phenomenon. Emphasis was on a broader goal of understanding phenomena through research. Unlike the previous subcategory, hypothesizing was not emphasized as an element in the process but undertaking a project or a survey so as to understand “what is going to happen and why”, with the final outcome being the ability to understand an event or a phenomenon.

*Inquiry is the process of investigation for the purpose of understanding ... such as [through] surveys and research projects. (79)*

*.... I'm guessing that it is some type of research, and the goal of it is to learn more about how students learn in the classroom. (151)*

**Discovery.** Here, inquiry was conceptualized as a means of discovering the unknown or new things. Instead of describing inquiry as a means to understanding through research, the focus

here was on the specific goal of discovering something new. Such conceptualization makes inquiry go further than being an endeavor of an individual student or a teacher. It relates inquiry to work carried out by scientists and its requirement of applying rigorous procedures.

*Inquiry is the process of questioning the unknown and discovering new things through rigorous testing. It is important to discover the nature of the unknown since it helps humanity evolve. (281)*

*Inquiry to me is about the discovery of new information, having some question with an unknown answer and taking both normal and traditional approaches, as well as non traditional approaches (554)*

**Improving practice.** Here, inquiry was conceived as doing research for improving practice. Improving teaching and promoting effective learning were given particular emphasis.

*.... I guess it is some form of data for research in education... then this is very important for education to help make teaching and learning easier and better. (182)*

*.... inquiry-asking questions... and research topics pertaining to teaching and learning. This is because not all students learn the same way and therefore, it is important for teachers to promote effective learning in class. (33)*

### **Indistinct Conceptualizations of Inquiry**

Beyond the three superordinate categories and the subcategories described above, a number of indistinct conceptualization of inquiry also emerged. That is, the participants either did not explicitly indicate goals and/or processes of inquiry (lack of meaningful idea units), or demonstrated that they had no idea about inquiry, or defined inquiry in a vague/very broad manner. Some instances of definitions classified as indistinct were:

*I have no idea - where a teacher reinforces ideas through questions? (49)*

*I think inquiry is a type of research. (106)*

*What teachers need to have to be a good teacher. (148)*

*I believe it is social constructivism teaching with possibly some research using this (192)*

*Investigation, question about (340)*

### **Prevalence of the Conceptions of Inquiry**

Frequencies of the occurrence of superordinate and subordinate categories were examined. Across all the participants, *inquiry as a means of gaining information/ knowledge* was the most prevalent conceptualization of inquiry followed by *developing knowledge and self-learning and knowledge construction*. There were overlaps in the occurrence of the

subcategories. That is, there were instances in which subcategories occurred in combination with each other. The extent of such overlapping occurrence can be seen in Figure 1.

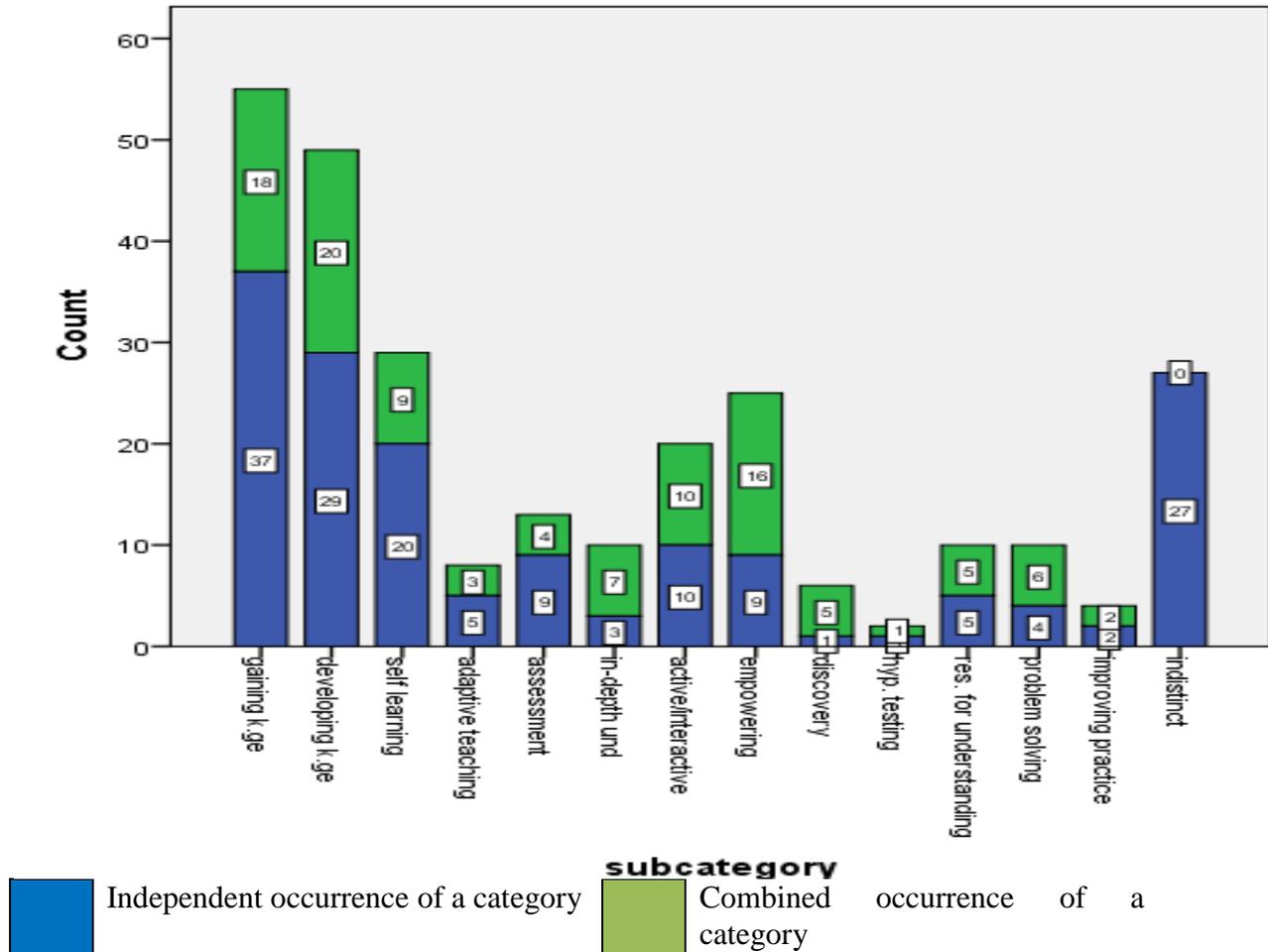


Figure 1. Pattern of occurrence of the subcategories among the participants

Examination of the subcategories classified under each of the superordinate categories revealed *gaining information/knowledge*, *empowering of students*, and *problem solving* and *researching for understanding*, respectively dominating the superordinate categories of *inquiry as a learning process*, *inquiry as an instructional process*, and *inquiry as a research/scientific process*.

When the three superordinate categories were rank ordered based on frequency of occurrence, there was greater emphasis on *'inquiry as a learning process'* and lesser emphasis on *'inquiry as a research/scientific process'* as depicted in Table 1.

Table 1  
*Frequency Distribution of the Superordinate Categories of Inquiry Conceptions*

Category (Inquiry as...)	Frequency*
a learning process	116
an instructional process	60
a research/scientific process	25
Total	185**

\*There were double coded definitions across categories. Hence, the summation of frequencies is greater than the total (185) due to double counting of cases for different categories.

\*\*This figure excludes 27 of the 212 definitions which were coded as indistinct conceptions

### Discussion and Implications

The findings from the present study are complementary to previous findings reported in the literature in that they have revealed categories of conceptions based on the students' definitions of *what inquiry is* and their explanations of its importance. The scholarly literature shows that inquiry is a multifaceted concept with no single agreed upon definition (Anderson, 2002; Aulls & Shore, 2008). The emergence of 13 categories as conceptions of inquiry in the present study illustrates how diversified students' understandings about inquiry are and can be taken as further evidence for the multifaceted nature of conceptualizing inquiry, even among an undergraduate student sample.

The emergent categories coincide with but are more comprehensive than those reported in earlier studies. For example, Demir and Abell (2010) came up with three ways of conceptualizing teaching science through inquiry: *problem solving on the initiative of the student*, *discovery learning*, and *an endeavor that relies on teachers' guidance*. Also a study by Haefner and Zembal-Saul (2004) revealed five categories by which participants understood science and scientific inquiry as: *an act of discovery*, *a way of seeking answers*, *a scientific process*, *a product*, and *a school science*. The first two categories from Demir and Abell's and the first three from Haefner and Zembal-Saul's studies were reflected in the categories of definitions obtained in the present study.

The present study, however, arrived at a different representation of students' conceptions of inquiry than reported in the study of Windschitl (2000). In his study of pre-service teachers, Windschitl reported three representations of the inquiry process by the participants: (a) *inquiry as a linear process*, (b) *inquiry as a bi-directional process*, and (c) *inquiry as a process involving mutually independent considerations*. In the present study the main focus was to know the participants' understanding of *what inquiry is* as a concept or process instead of mainly restricting them to depict the course of inquiry engagement to see how they represent the inquiry

process as was the case in Windschitl's study. They were rather asked to define what inquiry is and to explain its importance. Such difference in examining students' understandings of inquiry seems to have led to different results.

The comprehensiveness of categories of inquiry conceptions obtained in the present study can be attributed to the difference in the methods of eliciting participants' understandings about inquiry. Prior studies mainly examined inquiry understandings from the participants' reflective journals, field notes, observations, interviews, metaphors, or a combination of these (Demir & Abell, 2010; Haefner & Zembal-Saul, 2004; Windschitl, 2000) before and/or after explicit exposure to an inquiry-based experience in a course. In the present study, participants' were asked to describe their personal definitions of inquiry and explain its importance. Asking participants in such a direct way might have provided them more space to think and freely state their conceptions of inquiry rather than thinking only in the context of a specific inquiry-oriented course experience. This, added to the fact that the number of participants in the present study was far greater ( $n = 212$ ), might have resulted in a more comprehensive set of categories of conceptions of inquiry than those reported in earlier studies.

As conceptions have a potential role in influencing practices and orchestrate activities individuals do (Meyer et al., 2005; Pratt, 1992), the ways by which students conceptualize inquiry may have influence on their engagement and willingness to engage in inquiry. Students who conceptualize inquiry, for example, as a "self-learning and knowledge construction" endeavor are more likely to respond positively to teachers' efforts in creating a setting that intends to promote such type of learning than those who conceptualize inquiry as a mere endeavor of "gaining information/knowledge." When we particularly examine the categories of *inquiry as a means of self-learning and knowledge construction*, *inquiry as a means of empowering students*, and *inquiry as a means of problem solving*, they reflect high level of student active engagement and autonomy. Students with such conceptions of inquiry are more likely to become willing and motivated to engage in inquiry. Hence, the study suggests that creating the context that stimulates productive inquiry should take into account students' conceptions about inquiry by being aware of the conceptions and trying to enhance conceptions that promote rather than hinder inquiry learning.

Among the broad ways of conceptualizing inquiry in the literature, the conceptualization of it as the content or subject of learning was not revealed in the participants' definitions in the present study. Inquiry as the content or subject of learning denotes its representation as a topic of instruction by itself (Flick, 1995). Emphasis is on *learning about inquiry* (Minstrell, 2000), and on the *fundamental understandings* (National Research Council, 2000) students should develop about inquiry. It also denotes the awareness students should have about current research in the area of their discipline as well as the forms of discipline based inquiry (Healey & Jenkins, 2009). Students could acquire understandings of the nature of inquiry as a result of engagement in inquiry as a process or through explicit instruction about it as a complex set of concepts (Minstrell, 2000). Especially in higher education institutions, undergraduate students should experience learning through and about inquiry (Healey & Jenkins, 2009). The fact that conceptualization of inquiry as the content or subject of learning was not apparent among the undergraduates in this study suggests that they have less understanding of the core concepts that should be known about it as well as about the frontiers and forms of inquiry in their disciplines.

Given that helping every student to become an inquirer is at the heart of the mission of the higher education enterprise (Boyer Commission on Educating Undergraduates in the Research University, 1998), the non-existence of conceptualizing inquiry as the content or subject of learning may indicate that the undergraduate programs in the universities are not preparing students at a desired level of proficiency to become inquirers. This implies the necessity of providing students readings, reports, or books about research; engaging them in discussions concerning problems, data, interpretations, and conclusions; and allowing them to read about alternative explanations, assumptions, and use of evidences pertaining to scientific inquiry (Schwab 1960 cited in Bybee, 2000) as helpful strategies that professors can use to enhance students' fundamental understandings of inquiry.

The subcategories of inquiry conceptualizations under the superordinate category of *inquiry as a learning process* can conceivably show an increasing level of engagement in inquiry learning. The level and complexity of engagement in learning vary under the three subcategories of *gaining information/knowledge*, *developing knowledge* and *self-learning and knowledge construction*. Under *gaining information/knowledge*, the focus is on students' asking questions or making inquiries initiated by the curiosity to know about an event or a phenomenon. When inquiry is conceived as a means of *developing knowledge*, focus will be on furthering one's own understanding of what one already knows. And finally, conceptualization of inquiry as a means of *self-learning and knowledge construction* places the learner at the center of independent learning and knowledge construction. The "authenticity" of inquiry learning and the extent of active student participation in the process increase from the subcategory of gaining information/knowledge to self-learning and knowledge construction. This is complementary to what has been suggested in the inquiry literature in terms of representing it into different levels. In the literature, it is noted that there are different levels of inquiry depending on the amount of student self-direction involved as well as the cognitive demands inquiry tasks require. On such bases there are such increasingly more authentic levels of inquiry as confirmation, structured inquiry, guided inquiry, and open inquiry (e.g., Bell, Smetana, & Binns, 2005); or pre-inquiry, developing inquiry, proficient inquiry, and exemplary inquiry (Marshall, Horton, & White, 2009); or identifying, pursuing, producing, and authoring (Levy & Petrulis, 2012). Likewise, in the present study, the participants' conceptualization of inquiry as a learning process can be seen in terms of increasing levels of student engagement during the inquiry learning process. Such levels, in turn, imply the ultimate direction as well as the goals of students' inquiry learning experiences that should be promoted during instruction. As the more authentic form of inquiry learning is evident when students engage in self-learning and knowledge construction, the roles they need to be encouraged to take during inquiry learning should go beyond simply asking of questions to satisfy their curiosity. Thus, the students should be encouraged to formulate questions that help to promote self-learning and knowledge construction.

Examination of frequencies of superordinate and subordinate categories revealed that *inquiry as a learning process* in general and *inquiry as a means of gaining information/knowledge* in particular was the most prevalent conception. On the other hand, *inquiry as a research/scientific process* in general and *inquiry as hypothesis testing/hypothesizing* in particular was the least prevalent. The dominance of conceptualizing *inquiry as a means of gaining information/knowledge* suggests that formal schooling might not have allowed as many undergraduates entering universities to fully experience the inquiry learning process as educators

have assumed. This may explain why research has reported that some students resist and feel uncomfortable towards this approach to instruction (Aulls & Shore, 2008; Davidson & Bruce, 1993).

The fact that the participants' status at the time of the study was *student* and their very objective was *learning* might have influenced most of them to conceptualize inquiry as a learning process. There are claims that conceptions are context dependent (Marshall, Summer, & Woolnough, 1999; Marton, 1981). The status of individuals may influence their ways of looking at and interpreting events or phenomena (Eklund-Myrskog, 1997; Marshall et al., 1999). On the other hand, the participants' lack of experience engaging in research, or at least in learning about inquiry, may explain the low prevalence of conceptualization of inquiry as a research/scientific process. It may also be because what researchers or scientists do is somewhat far away from their status as a student. As a result, most of them were not looking at inquiry broadly outside the realms of teaching and learning. Allowing students to engage in inquiry on issues pertaining to real life experiences outside classrooms may help them develop more comprehensive conceptualization of inquiry.

### Limitation

In her study of undergraduate students' perceptions of strategic demands of inquiry learning and instruction, Syer (2007) claimed that the years of undergraduate academic study may matter in the quality of inquiry conceptualizations students can articulate. Beyond this, there are claims about disciplinary differences in inquiry (Breslyn & McGinnis, 2012). Hence, examining the conceptions based on years of studies and at the level of specific areas of study would be a contribution to the literature. Due to the presence of inadequate number of participants from across the year levels and from specific study areas, the study did not examine conceptions on the bases of these variables.

### Conclusion

The study revealed how diversified understandings about inquiry are and the most prevalent way of conceptualizing inquiry among an undergraduate student sample. As the education literature widely heralds, inquiry allows students to construct meaning and knowledge about phenomena for themselves (Atar, 2007; Aulls & Shore, 2008). However, the present study showed the rarity of underlying conceptions that can promote productive engagement in inquiry among the participants. This can particularly be evidenced by the less frequent occurrence of the superordinate category *inquiry as a research process* as well as the subcategory of *self-learning & knowledge construction*. Both of these results imply that the students are less ready to assume full responsibility for their own learning and to engage in inquiry. Consequently, giving undergraduates the opportunity to learn through and about research and inquiry (Boyer Commission on Educating Undergraduates in the Research University, 1998; Healey & Jenkins, 2009) is essential so that they will begin to perceive themselves as members of the scholarly community, will actively engage in research, and will assume full responsibility for their own learning.

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