Undergraduate Students' Experiences of Scientific Inquiry in a Web-Based Environment: A Descriptive Phenomenological Study

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Abstract – The continuous technological development has led to the emergence of web-based environment. Studies on information-seeking behavior existed, however, researches on undergraduate students'experiences in the web-based environment are limited. The photo-elicitation interviews ranged between 30-45 minutes. Using Giorgi's descriptive phenomenological method, five constituents emerged: importance of reliable search engines, criteria in evaluating reliable information, professional and peer-help in challenging situation, using varied references, and confidence in research writing. The result contributes to the knowledge of undergraduate students' behavior of scientific inquiry over the web-based environment.

Keywords – descriptive phenomenology, scientific inquiry, undergraduates, web-based environment.

INTRODUCTION

The web created opportunities in acquiring scientific information.Currently, information became accessible to almost all online publications [1]. However, Chung et al. [2] argued that scientific information acquired in the internet can sometimes be inaccurate and misleading because the web environment cannot automatically discern relevant from irrelevant information sources of scientific information [3]. Along with the popularity of using internet udergraduate students were confronted with dilemma including access to reliable sources. Description of students' experiences can shed light on how they obtain scientific information.

Scientific inquiry refers to the activities and methods of enhancing skills (e.g. predicting, analysing, classifying data, etc.) that contribute to scientific knowledge [4], [5]. Scientific inquiry and the nature of science are components of scientific literacy. However, scientific literacy not only emphasizing about scientific knowledge, but also, it extends beyond knowing the nature of science and scientific inquiry itself [5]. For decades, scientific inquiry was vital to education especially in science teaching and learning [2]. The educational system adapts to the technological advancements that occur every 6 to 12 months [6]. These advancements led to the evolution of information technology and changes in the society such as creating more demands, technological support, digital libraries, audio formats, printed formats, and computers [7] -[10]. Alongside the existence of computers, internet flourished [11].

The use of web-environment paved way for students to readily browse for information. For instance, scientific literacy is enhanced with opportunities for students to search and utilize scientific information [1]. In the higher education, undergraduate students prefer to work in the web-environment [12]. According to Bybee [13], scientific inquiry can be of significant help in strategizing teaching methods. Teachers have designed classroom integrating web into the learning environment. For example, in blended learning approaches such as flipped classroom [14] wherein student activities can be accessed online. Studies have shown that social media can be a platform for teaching[15], [16]. Alimboyong and Bucjan[15] revealed that familiarity, popularity and comfort level were the main reasons that instructors and students have positive acceptability of the platform. Domingo [16] revealed five reasons why students favor the use of Facebook in a language class: facilitates access to instructional materials, increases student's engagement, eases connectivity in a virtual community,

facilitates the accomplishment of class-related tasks and promotes the use of English among members.

Several researches using different approaches have been conducted on the information seeking behavior of students (e.g., virtual longitudinal study and grounded theory). In virtual longitudinal study, Rowlands etal.[17]has demonstrated that younger students rely much in using search engines. The study revealed that younger students lack analytical and critical skills in assessing the information acquired from the web-environment although students possess familiarity and ease in using it. However, Rowlands et al. [17] argue that analytical and critical skills are necessary in assessing the information students have acquired.

In the past decades, early studies of information seeking focused on scientists, researchers, and specifically on study groups [18], [19]. Weiler [19] formulated the first information seeking model from a general population with the following steps: to perceive a need for information, to search for information, to find information, and to use the gathered information. In addition, there are existing models about information needs and seeking behavior (eg, [20]-[22]).

In the information behavior model, Wilson [22] focuses on the user's perspective to search for information rather than computer-based searches. Ellis [20] described the information seeking behavior of researchers into eight categories; i.e., surveying, chaining, monitoring, browsing, distinguishing, filtering, extracting, and ending. Nevertheless, the stage process version of Ellis' model comprises of starting, chaining, differentiating, extracting, verifying, ending, browsing, and monitoring. Kuhlthau [21] information search process model contains initiations, task selection, exploration, search formulation, information collection, search closure, and starting writing.

Using grounded theory, Ellis [20] demonstrated several characteristics in the information seeking behavior, i.e., starting, chaining, browsing, differentiating, monitoring, and extracting. These steps in the information-seeking behavior are interlinked, interchangeable in sequence, and complementary to each other. On the other hand, Ellis [20] only derived information seeking model from experts on the field, i.e., social scientists, engineers, research scientists, physical science researchers, social science researchers, and academic researchers. Hence, there is limited research concerning the information seeking behavior of undergraduate students over the web-based environment. To fill the gap, phenomenology can describe the students' scientific inquiry in a web-based environment.

This paper provides brief description of undergraduates' information seeking behavior such as scientific inquiry in a web-based environment.

OBJECTIVES OF THE STUDY

With a purpose of describing the phenomena perceived among the persons involved in the situation or experience [23], this study was conducted to describe the undergraduate students' experience of scientific inquiry in a web-based environment.

METHODS
Research Design

A descriptive phenomenological method [23]-[24] was used in the study, which investigates the "lived experiences" of undergraduate students. Descriptive phenomenological method seeks to describe a phenomenon [25]. Giorgi [26] utilized the descriptions of people's experiences. Central features in descriptive phenomenology are: (1) the researcher gathers a detailed description of the participant's experience, (2) the researcher adapts a phenomenological attitude to fully understand the experience, and (3) the researcher explicates the most homogenous meanings from the context of the experience [27]. According to Welch & Barr [28], key features in understanding descriptive phenomenology are intentionality, reduction, and natural attitude. However, Miles et al. [29] pointed out that practitioners began to expand their phenomenological research procedures. Hence, the researchers employed the photo-elicitation method in descriptive phenomenology. Harper [30] defined it as a method of inserting photos to interviews that evokes a person's consciousness.

Participants

The participants were the undergraduate students of Visayas State University (VSU) who took up science-related courses during second semester, school 2018-2019. Since the researchers used descriptive phenomenology, the goal of the study was to make a description of the information gathered [31]. Giorgi [25], [26] suggested that the researchers should at least gather three participants for the study so that it will be easier to handle the gathered information. Considering the suggestion of Giorgi [25], [26], the researchers have decided to gather three participants.

The variation between the participants indicated a variation in the phenomenological discussion. Perera, et al.[32] stated that "phenomenology includes discussion

about variations in the manifestation of an experience due to demographic variation" (p.36).

Table 1. Demographic profile of the participants

Participant (P)	Age (years)	Gender	Civil Status	Time spent (hours)	Internet Access
1	21	Male	Single	2	Internet cafe
2	28	Male	Single	8	Own connection, Mobile data
3	20	Female	Single	3	Mobile data, Internet cafe

The participants were characterized as P1, P2, and P3. All of the participants were 20-28 years old. Moreover, two of them were male and one was female. Regarding the civil status, all of them were single. Concerning the financial support, P1 depended on his siblings; P2 was self-supporting; and P3 relied on her parents. Furthermore, the time they spent on the internet ranged between 2-8 hours. In accessing the internet, P1 goes to an internet café; P2 relied on his own connection and mobile data; and P3 goes to the internet café and relied on mobile data.

Data Collection and Research Tools

Purposive sampling was employed in the selection of participants [31]. The semi-structured interview guide was developed and used in formal in-depth interviews [31],[32]. Demographic profile forms and written consents were also distributed to the participants before the interview. According to Dale [33], the length of interviews ranges from half an hour or more. In this study, the interviews lasted between 30-45 minutes.

Photo-elicitation was integrated in the interviews. Harper [30] argued that using photographs in interviews stimulates more information from the person being interviewed. Thirteen photos about the frequently used websites and scientific websites were shown to the participants. Afterwards, the conversation between the researchers and participants were audio-taped with the use of a cellular phone. The recorded data which is in Visayan dialect were transcribed in verbatim.

Ethical considerations for human participants were strictly followed [34]. The researchers prepared and signed a transmittal letter. In order to conduct the study, a senior faculty and the Dean of the College of Education signed the letter. A formal Informed Consent was sent to the participants prior to the one-on-one interview. The data was dealt with utmost confidentiality; participants were coded as P1, P2 and P3. Lastly, after the interview, the participants were given a token of gratitude.

Data Analysis

The descriptive phenomenological analysis was used in the study[25], [26]. In Giorgi's method of phenomenological analysis, four steps were considered: (1) reading the interview transcripts for several times in order to get the overall meaning of the experience, (2) discerning the meaning units from the text read, (3) expressing the constituents of these meaning units, and (4) synthesizing the meaning units together with its constituents by making a general structure of the experience. In this study, the term "constituents" was preferred instead of themes so that it can decipher how the meaning units interact with each other when making the general structure. Holloway [27] believed:

> "to be coherent within this approach, the analysis needs a strategy that is mindful of a 'back and forth' movement between particular meanings and the sense of the text or experience as a whole. A 'part meaning' is thus not given more value just because it occurs more times. This is why the term 'content analysis' is avoided and the term 'constituent' is often used in order to indicate a concern with how the 'part meanings' function together and interactively make up the whole" (p. 96).

RESULTS AND DISCUSSION

Importance of Reliable Search Engines

Being undergraduate students, they recognized the importance of using reliable search engines (i.e., Google Scholar). All of the participants stated that it is important to know the reliability of search engines because due to the rise of information technology, fake information also increases in the web-environment. P2 uses Google because it is comfortable to use, and Google Scholar because it is usually recommended by his instructors,

> *"Actually…Google man gyud ang gamiton…mas komportable ko mogamitsa Google tapos kung naakoymga important nga research so gamit rag Google scholar maona usually… based sa discussion sa among previous namga instructor … para maka generate mi ug information gikansakadtongmga scholarly ngamga articles"*[Actually, I usually use Google. I am more comfortable using it for more important research I used Google Scholar upon

recommendation with the previous instructors to generate information from the scholarly articles.]

The information seeking behavioral model of [20] contained six components, i.e., starting, chaining, browsing, differentiating, monitoring, and extracting. The first component of Ellis' information seeking model was the 'starting' phase, which is the preliminary part of information-seeking behavior where one identifies an information source. Ellis [20] believed that "these sources are likely to point to, suggest, or recommend additional sources or references". Using Ellis' model, Choo etal.[35] reported that the 'starting' phase of information-seeking can be used as starting points to locate other reliable information sources. All participants have experiences with Google and Google scholar. On the other hand, free online encyclopedia where anyone can create or edit articles, was used as a source of general information. But, it was not used as a citation nor reference.

Selwyn & Gorard [36] reported that 87% of the undergraduate students interviewed used Wikipedia restrictedly. According to Kim et al. [37] Wikipedia arouse as an important source of information for undergraduate students. P3 and P2 used Wikipedia as supplementary and preparatory information sources.

Table 2. Importance of reliable search engines

Constituent	P1	P2	P3
Importance of reliable search engines	P1 stated that Google Scholar is a reliable site for downloading articles related to thesis.	P2 stated that Google scholar is usually recommended by their previous research instructors.	P3 stated that "in terms of reliability and available information, Google Scholar is more preferable.
	P1 stated that Google is a reliable site for downloading articles related to thesis.	P1 stated that Google is faster and comfortable to use.	P1 stated that Google is commonly used and easily accessible.

P1 also stressed out that Wikipedia has reliability issues. Given that Wikipedia is a voluntary type of publication site, people from all over the world can freely post reliable and unreliable information [38]. However, Colepicolo [39] argued that it can still be used as a general reference for researchers.

Criteria in Evaluating Reliable Information

All of the participants have their own 'unique' criteria in evaluating the reliability of information. But, their criteria have some similarities: (1) to check the reliability of information source, (2) to read some parts of the articles (e.g. abstract, results and discussion, references, etc.), and (3) purchasable, peer-reviewed, published, and latest articles are reliable.

The criteria of the participants in evaluating reliable information complemented the study of Wu and Tsai [41]. The independent variable (evaluative standards) directly affected the dependent variable (information searching strategies). Hence, there was a significant relationship between a person's evaluative standards on information seeking behavior on web-based environment. It signifies that a more refined method of searching information can be obtained through advanced criteria. This served as an important step for information seeking strategies on web-environment.

Tsai [41] elaborated that there are 'views' accompanied in assessing reliable information. The 'functional' view was taken into consideration because "inaccessibility" of some information sources sometimes leadthe participants to frustrations and uneasiness. Meanwhile, the 'content' view was usually perceived by the participants when they are checking the search results through matching, elaborating, and exploring the information resources. In his transcript, P1 said:

> *"…for me because I…read the article word for word so everytimena motan-aw ko sa…graphs or…tables about sailang data ako gyud tan-awonsailang results and discussion…ako pud tan-awon ang…references…for example the title of the journal…, author,…background samga author then kung makitan to nako na nga…attributes sa paper so that's the time I consider it as reliable."*[For me, I read the article word for word, so every time I look at the graphs or tables, I read the results and discussion. I also examine the references, title of the journal, author, and author's background. These are attributes I consider reliable.]

Table 3. Criteria in evaluating reliable information

Constituent	P1	P2	P3
Criteria in evaluating reliable information	P1 considers reliability of the site.	P2 states that he goes to a renowned or reliable journal publication/s.	P3 considers reliability of the site.
	P1 reads an article's abstract, results and discussion, references, journal title, and author's background.	P2 reads an article's abstract, results and discussion, review of literature, introduction, and methods.	P3 reads an article's abstract, methodology, and conclusion.
	P1 states that published, peer-reviewed, purchasable, and latest journals are reliable.	P2 states that he goes to a renowned publication (published and peer-reviewed).	P3 considers a journal's date of publication and rating.

Professional and Peer-help in Challenging Situation

When difficult situations arise, the participants always sought to seek help from peers and professionals. All of the participants stated that they have experienced difficulties in scientific inquiry over the web-based environment. Ozgen & Baron [42] verified that there are positive effects when a person seeks help from human resources when facing perplex situations in scientific inquiry. This implies that the assistance of mentors (i.e., thesis advisers and authors) was important for the protégé's (undergraduate students) to avoid problems in undertaking knowledge and valuable information. Asking help from his research adviser is P1's alternative way of working efficiently. P1 acknowledged that,

> *"…there are several times I consulted for example my previous adviser Dr. J. F….and asked if she had these articles which are related to my study, so ma'am J.F. is very generous…she gives a lot of articles so I don't have to search for it anymore."*

Dr. J.F., the previous research adviser of P1, gave him some articles that are related to his study. After receiving help, he felt reassured. P2, on the other hand, sought help from professionals and peers. The students sent emails the authors for free copies of their books that need payments. Moreover, he asks help from his peers (i.e.

friends) by inquiring them for free copies of books that they have accessed.

> *"…my experience…with those books that requires payment and I really need that book sometimes I have to look at who is the author then I send message to the author…not all the authors that I sent my messages replied on me but majority of those replied…they gave me the whole copy of the books…if you have some friends especially in other schools that they have access to that for free then you have to ask for them…"*

Several researchers (eg, [43], [44]) proposed that the efficacy of peer mentoring between mentors and mentees can be seen through a motivational feedback, ease, adaptability of values, conducts, and ethics. These attributes reveal and strengthen the personal identity of the undergraduate student. Additionally, Ehrich, et al. [45]explained that in 32.1% of studies, discussions and communication with other people contributes to a positive disposition for mentees.

Table 4. Professional and peer-help in challenging situation

Constituent	P1	P2	P3
Professional and Peer-help in challenging situation	P1 emails authors for free copies of their articles.	P2 emails authors for free copies of their books.	P2 confirmed that she has not tried emailing authors.
	P1 seeks help from thesis adviser several times.	P2 seeks professional advice and guidance from thesis adviser and instructors.	P3 seeks help from thesis adviser.
	P1 did not mention about seeking help from his peers.	P2 seeks help from peers with a similar study.	P3 seeks help from Student Research Committee).

Using Varied References

Many references have been utilized in making researches such as journals, electronic books, and articles. These references may either be downloaded via online publications or in the libraries. In scientific inquiry, one of P3's strategies was to download lots of information sources in the internet. P3 said,

> *"I downloaded…related saako study…ang akogi-visit…Department   of*

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Agriculture…PhilRice…IRRI…JournalofEcon omics…African Journal of Agriculture andEconomics…Springer... Naa man…ko'ydaghan links…" [I downloaded related to my study. I visited [websites of] Department of Agriculture, IRRI, Journal of Economics, African Journal of Agriculture and Economics, Springer. I have plenty of links]

Even though P3 wanted lots of references, she did not automatically rely on the topmost information in the search results. Instead, she even scrolled down for more information.

Coherently, Dilevko and Gottlieb [46] stated that not all information sources in the internet are reliable because some information was incomplete, inaccurate, and inaccessible. References are important components in scientific research [47]. So, the participants still believed that it is necessary to consult for books in the library because not all the information people wanted were available in the internet. It is the main reason why P2 visits the library more often. As what he said,

"Ok, mga ways nako, I will …run to library kung wala gani information nga available sa internet". [ok, I have several ways, I will go to the library there are no available information over the net.]

Confidence in Research Writing

Undergraduate students have 'confidence' within themselves. In engaging scientific inquiry, there are factors that can increase an undergraduate's confidence: (1) to know the credibility and source of information, (2) to read the references thoroughly, and (3) to collect lots of journal sources.

As to Kuhlthau [21], the 'formulation' stage of information search process is the stage where a person's level of confidence increases and uneasiness decreases. All the participants felt like they want to 'improve' their information seeking skills in the latter stages of scientific inquiry. P2 strongly believed that improving his skill in research writing increases his confidence in scientific inquiry. Based on his response,

"…because I really wanted to make a fast output so I read only the needed information…not actually… reading everything that was written in the articles. I just browse and when…this information is relevant to my study, I get that information right away but I have to cite…the author or the reference…I think it is also important that you have to go through the whole… book especially the results and discussion because that is…also equally important because from there you will know that this… study are effective…or did the result compensate the introduction… the purpose…or objective of the study..."

Table 5. Using varied references

Constituent	P1	P2	P3
Using varied references	P1 uses downloaded journals, and electronic books as references.	P2 generates information from scholarly articles.	P3 generates information from recently published articles.
	P1 refers traditional books as additional references.	P2 remembers going to the libraries for further references.	P3 tried using books for information.
	P3 used various links for references.	P3 used various links for references.	P3 used various links for references.

Table 6. Confidence in research writing

Constituent	P1	P2	P3
Confidence in research writing	P1 recognizes the importance of knowing the credibility and source of information.	P2 recognizes the importance of knowing the credibility and source of information.	P3 recognizes the importance of knowing the credibility and source of information.
	P1 reads articles thoroughly.	P2 recognizes the need of reading articles thoroughly.	P3 recognizes the need of reading articles thoroughly.
	P1uses lots of journal sources for reference.	P2 recognizes the necessity of having lots of journal sources.	P3 recognizes the importance of having an adequate number of reference materials.

Gormally et al.[48] found out that students gain confidence and develop their scientific literacy skills when doing scientific inquiry. Pajares [49] also supported that people's beliefs in accomplishing tasks are predictors of how they improve their own skills. Therefore, confidence in their own abilities affects their research writing skills.

CONCLUSION AND RECOMMENDATION

In the context of an undergraduate students' experience of scientific inquiry in a web-based environment, the participants have recognized the importance of reliable search engines (e.g., Google scholar) from unreliable search engines. Participants also set their individual criteria in knowing information credibility such as considering the reliability of information sources, reading some parts in the articles (i.e., abstract, results and discussion, references, journal title, author's background, review of literature, introduction, methods, and conclusion), and assessment of reliable articles on a particular basis (up-to-date, purchasable, peer-reviewed, and published). When the participants' face challenging situations, they seek help from professionals and peers, i.e., emailed authors for free copies of the articles, asked help from thesis advisers and peers of similar study. The participants also utilized varied references such as electronic books, journals, scholarly articles, recently published articles, traditional books, and various links for references. Lastly, the confidence level of participants in research writing was increased by recognizing the significance of reliable information sources, reading the articles thoroughly and having lots of journal sources.

The web-environment has a strong influence on undergraduate students' scientific inquiry. Since most undergraduates rely heavily in the web-environment, practices on scientific inquiry must be practiced. The presence of intermediaries is needed to assist undergraduate students in their scientific inquiry in the web-environment. Mentoring between students and teachers are critical element of student's success. Teachers can provide consultation time. Promote the utilization of printed books as references. Future studies should focus on information seeking behaviour of young learners (e.g., senior and junior high school students) and out-of-school youth.

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