Instruments and Implements of Enquiry Based Learning

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Abstract

Enquiry, Inquiry, Problem Solving etc. are all different terms describing one outcome, that is creating an environment where students are driven by curiosity, involved and in charge of their learning. The problem of a traditional classroom has always been that students are spoon fee with information and most of it is lost in time if it is not used and applied. This paper introduces enquiry based learning and explores the important factors that assist teachers in using it easily in their classrooms.

This document reviews selected studies articles to try to produce simplified document to assist teachers in using inquiry-based learning in their classrooms. This paper will assist not only teachers but also school leaders in defining the most important criteria for preparing and conducting a classroom rich with enquiry based learning. The study may also assist them in identifying strategies to help make the classroom environment more enquiry driven. This will in turn enable students to investigate and develop their potentials based on their own unique interests. Providing students with such an environment will encourage them to become valuable contributors in the school as well as in their communities.

Introduction

> "Humans are born inquirers. You can see it from the moment of birth: Babies use all of their senses to make connections with their environment, and through those connections they begin to make sense of their world. As children discover objects and situations that are puzzling or intriguing-things that provoke their curiosity- they begin asking questions and looking for ways to find answers, all in an effort to understand the world around them. This is the essence of the inquiry process"
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> > (Division of Elementary, Secondary, and informal Education, Directorate for Education and Human Resources, n.d , p. VII)

Student achievement is the single most important factor in determining the success of any

educational organization around the world. It is also important to note that student

achievement is facilitated by teachers and supported by a school environment that values

students' minds. This kind of environment gives students the responsibility for deciding on

the content of their lessons and empowers them to take control of their learning. As Morgan,

Williamson, Lee and Facer (2007) explained in their Enquiring Minds' publication,

> In order for learning to be truly educational, the experiences and ideas that students bring to the classroom need to be viewed from different angles and different perspectives; students need to be supported to be curious about, to challenge, and to enquire into their experiences, interests, assumptions and aspirations." (p. 16).

It is also imperative to highlight that while most traditional schooling undermines students'

previous knowledge and potential, the new educational model adopted by most of the leading

nations and schools around the emphasizes the importance of the students' knowledge,

involvement and contribution in their learning (Morgan, Williamson, Lee, Facer and

Futurlab, 2007).

The new educational model emphasizes enquiry-based learning is leading the new

educational era. The goal is to create classrooms where knowledge is presented by teachers,

shared and discussed in an open way, applied in real life context and finally critically

evaluated by students. This paper will assist teachers in their quest towards setting up an

environment rich with enquiry-based learning and will also guide them in how to maintain it

and evaluate the effectiveness of such environment.

Research Methodology

This paper was conducted in an effort to produce a more user-friendly document to assist

teachers and school leaders in promoting and sustaining a learning environment rich with

enquiry-based learning. The information in this paper was obtained through conducting a

literature review of the most popular publications on enquiry based learning to date. The

literature review search process produced 27 publications, that were later short listed and organized in three categories:

1. Definitions of Enquiry Learning,

2. Creating an Enquiry Based Learning Environment and

3. Sustaining an Enquiry Based Learning Environment.

The paper will describe and elaborate on those three categories to help teachers and school leaders understand, use, and maintain an environment built on enquiry learning.

Definitions of Enquiry Learning

Many writers, thinkers and researchers have defined enquiry learning using different words and styles many of which relate to the same concept as described by the National Science Foundation publication (Division of Elementary, Secondary, and informal Education, Directorate for Education and Human Resources, n.d).

> "Inquiry is an approach to learning that involves a process of exploring the natural world, and that leads to asking questions, making discoveries, and rigorously testing those discoveries in the search for new understanding." (p. 2)

Enquiry based learning has become an important ingredient in a successful educational system. It is important to understand that the mere input of data in to the students' minds is considered old school teaching. In today's day and age studies have proven that students' intake of information is easily lost with time if no practical application or sense was made of it. In the traditional education system, we are only producing machines that took information, used it in an exam, and sooner or later the information was lost because it was not put in a meaningful real life context (Exline, 2009). Exline (2009) in his workshop about enquiry based learning explained that:

"Educators must understand that schools need to go beyond data and information accumulation and move toward the generation of useful and applicable knowledge…a process supported by inquiry based learning. In the past, out country's success dependent on our supply of natural resources. Today, it depends upon a workforce that {works smarter}." (p. 2)

In another paper produced by the Centre for Excellence in Enquiry-Based Learning, Dr. W Hutchings explains that to live in this world, humans need to commit to action; therefore, they cannot be static receivers of information.

Creating an Enquiry Based Learning Environment

The need for students to become active learners is the agreed upon strategy by many researchers and educators. Enquiry based learning is the environment that needs to be created in order for this active learning to take place. Dr. Bill Hutchings (2006,) explores the methods of enquiry based learning by outlining the different factors involved in the different kinds of enquiries in the different areas of knowledge and levels of student experience. They include:

1. The selection of appropriate questions.
2. The formulation of appropriate questions.
3. The identification of key issues.
4. The search for valid and relevant evidence.
5. The interpretation, and assessment of evidence.
6. The application of evidence to indentified issues.
7. The presentation of coherent conclusions, final or tentative.
8. The reflection on, and assessment of, the learning process. (p.3)

The National Science Foundation in their Foundations production, (Division of Elementary, Secondary, and informal Education, Directorate for Education and Human Resources, n.d) explained the process of enquiry in an easy to understand steps as follows:

The process begins when the learner notices something that intrigues, surprises, or stimulates a question-something that is new, or something that may not make sense in relationship to the learners' previous experience or current understanding.

The next step is to take action-through continued observing, raising questions, making predictions, testing hypotheses, and creating theories and conceptual models.

> ***The learner must find*** his or her own pathway through this process. It is rarely a linear progression, but rather more of a back-and-forth, or cyclical, series of events.
>
> ***As the process unfolds,*** more observations and questions emerge, giving occasion for deeper interaction with the phenomena-and greater potential for further development of understanding.
> ***Along the way,*** the inquirer collects and records data, makes representations of results and explanations, and draws upon other resources such as books, videos, and the expertise or insights of others.
>
> ***Making meaning from the experience*** requires reflection, conversation, comparisons of findings with others, interpretation of data and observations, and the application of new conceptions to other contexts. All of this serves to help the learner construct a new mental framework of the world (p.2).

The teacher's role in an enquiry based learning environment is to guide children in finding the answers on their own along with encouraging them to ask new more challenging questions during the process (Youth Learn, 2009). In their publication *Enquiring Minds,* Morgan, Williamson, Lee and Facer (2007) also described the characteristics of a good enquiring mind teacher as having:

- A thorough understanding of how knowledge is produced, and a desire to learn about how ideas and knowledge are produced in subjects other than their own.
- An ability to produce knowledge, ie to research topics, to find out, to make connections between ideas.
- An understanding of the social context in which she or he is operating.
- Insights into the lives of students and a willingness to engage with aspects of students' cultures.
- An appreciation of critical educational goals and purposes. (p. 26)

In their website, Youth Learn (2009) explain that "inquiry-based learning projects are not unstructured; they are differently structured. If anything, they require even more planning, preparation, and responsiveness from the educator-its' just that the educator's role is different" (p.2).

Course matter is another very critical area in which enquiry should be embedded. In a publication on enquiry-based learning Resource Pack, Dr. Bill Hutchings (2006) proposes

that "An effective, well-designed enquiry based learning course may need to meet the following criteria:

- The material must stimulate students to engage in an active process of discovery.
- The stimuli (the 'problems', the 'scenario') need to be open enough to allow of a range of possible and, at the same time, intellectually valid.
- The stimuli need to be specific enough to allow of an adequate response within the time-scale and resources available.
- The stimuli need to be matched to the level of experience of the students.
- Ideally, the stimuli will situate the task within a context that allows the students to demonstrate a range of skills, both subject-specific and transferable (e.g. team-working)
- The material must be academically robust, and so enable responses to meet appropriate academic criteria. It therefore follows that material can be produced only be fully trained academic experts. (p. 2)

If students are exposed to this kind of teaching it will have an insightful effect on students' learning since it challenges them to think using their enquiry skills to make sense of information.

The features of enquiry pedagogy as described by Morgan, Williamson, Lee and Facer (2007) encourage the realization that teacher and students are co-workers; a teacher should use his/her knowledge and understanding to elicit students' knowledge. It also helps in the realization that the classroom is a place where teacher and students think together and develop ways to talk together. Student should take on more responsibility for how the classroom should be and how learning takes place. Finally students should be able to choose the course content and teachers adapt and respond to it (Morgan, Williamson, Lee, Facer and Futurelab, 2007).

Within the classroom, the process of enquiry involves different patterns of time management and organization of space. This process of timing and spacing work well when employing

differentiated learning with different students in one classroom. Morgan, Williamson, Lee and Facer (2007) explain this concept by giving the example:

> "It is possible to imagine lessons being geared to the paces of individual learning. Different students may be working at different speeds and in different parts of the classroom. In an Enquiring Minds classroom, students will have greater role in determining when a task is finished, or how long they wish to spend on a task." (p. 30)

At the classroom level, ensuring an enquiry-based atmosphere is the teacher's responsibility; but at the organizational level, enquiry based learning should be the principal's aim in creating the school environment. It should be applied not only in the classroom, but also among staff and between students in an educational and/or extracurricular/vocational perspective. If school leadership advocate enquiry based learning, then this in turn will encourage and fosters enquiry within teachers to become enquirers (i.e. involved in every educational process). Research has also proven that enquiring teachers will most likely raise enquiring students. In their guide, Morgan, Williamson, Lee, Facer and Futurelab (2007) organize creating an enquiry based learning environment into scales of implementation as follows:

Preparing For Enquiry Approaches	How	Enquiring Minds in Practice	How
Step 1: Teachers operate in their own subject areas but allow students to define an area of that subject that they want to look into further, probably from a selection of themes the teacher feels adequately prepared for in advance.	Single teacher Within subject Student choice from selection	**Steps 4 and 5**: Are what Enquiring Minds looks like when ambitiously implemented across school.	
Step 2: A whole department of teachers work together to develop a wider range of possible activities and themes for students to pursue.	Whole department Increasing student free choice and initiative Team planning	**Step 4:** Is characterized by students having timetabled space to carry out enquiries that are not especially tied to any single subject (although a range of subject knowledge may inform them along the way, where appropriate).	Across school Student-initiated Reactive team planning Off-curriculum

			Dedicated timetable space
Step 3: Involves different departments operating together in order to reinforce the ways in which different subjects look at different sorts of knowledge. Increasingly at this level of implementation students should be able to define ideas for projects that teachers then work to link together through subjects.	Cross-curricular/ Interdepartmental Thematic teacher-led then student-initiated.	**Sept 5:** Involves the entire school. A large proportion of teaching and learning at this stage takes place in the context of a school which recognizes and values students' existing knowledge and experiences, and engineers large parts of its curriculum around them.	Whole school All staff All pupils Relevant to experience Integrated curriculum Reviewed timetable.

Adopted from materials created by Enquiring Minds (2007, p.54-55)

Sustaining an Enquiry Based Learning Environment

Success of an enquiry based learning environment is assessed by many indicators, one of which is the level of student enthusiasm in the classroom and during activities. Students should be challenged by an activity in order to reach a level of excitement. A science teacher wrote about her experience in enquiry based learning saying:

> "I measure my success by the level of enthusiasm in the classroom, as well as the level of thinking that goes on there. My students look forward to science and feel confident about their capacity for conducting scientific investigation. Their questions are realistic and grow in sophistication." (Marrero, 2000, p. 1)

Marrero (2000) also explains that "Watching how involved students become in their inquiries is for me the greatest evidence of the value of scientific inquiry in the classroom." (Marrero, 2000, p. 1)

Other writers elucidate the importance of asking good questions in a classroom as an indicator to help in sustaining an enquiry based learning environment. In a workshop presented by Exline (2009) in Thirteen ed. online classroom called *Enquiry Based Learning*, Exline wrote:

"The teacher functions more as a facilitator who coaches, mediates, prompts, and helps students develop and assess their understanding and thereby their learning. One of the teacher's biggest jobs becomes ASKING GOOD QUESTIONS." (p. 1)

In a similar effort some unknown authors in the *From Now On*, The Educational Technology Journal, developed A Questioning Toolkit which they propose should be created by districts or schools to contain several kinds of questions and questioning tools. They advise that such Questioning Toolkit "should be printed in large typed on posters which reside on classroom walls close by networked, information-rich computers." (From Now On, 1997) The categories of questions they outlined in their publication were:

1. **Essential Questions**: These are questions which touch our hearts and souls. They help to define what it means to be human.
2. **Subsidiary Questions**: These are questions which combine to help us build answers to our essential questions. Big questions spawn families of smaller questions which lead to insight.
3. **Hypothetical Questions**: These are questions designed to explore possibilities and test relationships. They usually project a theory or an option out into the future, wondering what might happen if! They are helpful when trying to decide between a number of choices or when trying to solve a problem.
4. **Telling Questions:** These questions lead us right to the target (like a smart bomb). They are built with such precision that they provide sorting and sifting during the gathering or discovery process. They focus the investigation so that we gather only the very specific evidence and information we require, only those facts which illuminate the main question at hand.
5. **Planning Questions**: These questions lift us above the action of the moment and require that we think about how we will structure our search, where we will look and what resources we might use such as time and information. Effective researchers develop plans of action in response to Planning Questions.
6. **Organizing Questions**: These questions make it possible to structure our findings into categories which will allows for construction of meaning. The less structure we create in the beginning, the harder it becomes later to find patterns and relationships in the fragments or the collection of bits and pieces.
7. **Probing Questions**: These questions take us below the surface to the "heart of the matter". They operate somewhat like the archaeologist's tools- the brushes which clear away the surface dust and the knives which cut through the accumulated grime and debris to reveal the outlines and ridges of some treasure. They help us push search strategies well beyond the broad topical search to something far more pointed and powerful.
8. **Sorting and Sifting Questions**: Those questions enable us to manage info-Glut and Info-Garbage- the many pages and files that come up when conducting a research. Relevancy is the primary criterion employed to determine which pieces of information are saved and which are tossed overboard.

9. **Clarification Questions**: These questions convert fog and smog into meaning, a mountain of information may do more to block understanding than promote it. Defining words and concepts is central to this clarification process.
10. **Strategic Questions**: These questions focus on ways to make meaning, they arise during the actual hunting, gathering, inferring, synthesizing and ongoing questioning process. They are closely associated with Planning Questions.
11. **Elaborating Questions**: These questions extend and stretch the import of what we are finding. They take the explicit and see where it might lead. They also help us to plum below surface to implicit meanings.
12. **Unanswerable Questions**: These are the ultimate challenge. They help tell when we have pushed insight to its outer limits in which we may never find Truth, but we may illuminate, extend the level of understanding and reduce the intensity of the darkness. Students trying to formulate Essential Questions must be prepared for the strong likelihood that their questions may be unanswerable and that this is acceptable.
13. **Inventive Questions**: These questions turn our findings inside-out and upside-down. They distort, modify, adjust, rearrange, alter, twist and turn the bits and pieces we have picked up along the way until we have proclaimed the discovery of something brand new.
14. **Provocative Questions**: These questions are meant to push, to challenge and to throw conventional wisdom off balance. They give free rein to doubt, disbelief and scepticism.
15. **Irrelevant Questions**: These questions take us far afield, distract us and threaten to divert us from the task at hand and that is their beauty! The creation of new knowledge almost always requires some wandering off course.
16. **Divergent Questions**: These questions use existing knowledge as a base from which to "kick off". They move more logically from the core of conventional knowledge and experience than Irrelevant Questions. They are more carefully planned to explore territory which is adjacent to that which is known or understood.
17. **Irreverent Questions**: These questions explore territory which is "off-limits". They challenge far more than conventional wisdom. They challenge far more than conventional wisdom and hold no respect for authority or institutions or myths. (p. 3)

Ash and Kluger-Bell in *Indentifying Inquiry in the K-5 Classroom* (Division of Elementary, Secondary, and informal Education, Directorate for Education and Human Resources, n.d), set forth principles in which I believe apply to all classroom levels with rising complexity as the grade advances. They tried to answer questions like, What does an enquiry classroom look like? How does it work? How can you tell if genuine inquiry is happening in the classroom? (Division of Elementary, Secondary, and informal Education, Directorate for Education and Human Resources, n.d.)They offered three practical guides to help educators who are trying to identify and support the specialised characteristics of the enquiry environment they are:

1. **What Are The Students Doing?**

   In this section Ash and Kluger-Bell explore few categories that should be examined when looking for indicators of enquiry based learning in students (Division of Elementary, Secondary, and informal Education, Directorate for Education and Human Resources, n.d)

   - **Active participation** of students in the process of learning. For example, do students look forward to going to class? Are they confident and demonstrate a willingness to modify ideas, take risks and display healthy scepticism? Do they seek collaborate and work cooperatively with their peers and respect individuals and their differing points of views?
   - Whether or not students are **readily engaged in the exploration process**. For example, do they exhibit curiosity and ponder observations? Do they take the opportunity and time to try out and preserve with their own ideas?
   - Whether students are **planning and carrying out investigations**? For example, do they designing a fair test as a way to try out their ideas, not expecting to be told what to do? Do they carry our investigations by handling materials with care, observing, measuring and recording data? Do they plan ways to verify, extend, or discard ideas?
   - **Students' communicate using a variety of methods**. For example, do they express ideas in a variety of ways: journals, reporting out, drawing, graphing, charting etc.? Do they listen, speak and write about the subject with parents, teachers and peers? Can they communicate their level of understanding of concepts that they have developed to date?
   - Students should also **propose explanations and solutions and build a store of concepts**. For example, can they offer explanations both from a "store" of previous experience and from knowledge gained as a result of ongoing investigation? Do they use investigations to satisfy their own questions? Do they sort out information and decide what is important? Are they willing to revise explanations and consider new ideas as they gain knowledge?
   - **Students' raising questions** is another very important indicator. They could either ask questions verbally or through action or use questions that lead them to investigations that generate or redefine further questions and ideas? Do they value and enjoy asking questions as an important part of a subject?
   - **Students using observations** is also an important indicator. For example, do they observe carefully, as opposed to just looking? Do they see details, seek patterns, detect sequences and events; they notice changes, similarities and differences? Can they make connections to previously held ideas?
   - Finally **Students should critique**. For example, do they create and use quality indicators to assess their own work? Do they report and celebrate their strengths and identify what they'd like to improve upon? Do they reflect with adults and their peers? (p. 80)

2. **What is The Teacher Doing?**

   Ash and Kluger-Bell also highlighted some skills a teacher must develop in order to support student learning of scientific ideas. Therefore when entering an enquiry based classroom the following should be observed from the teacher:

- **Model behaviours and skills**. For example, do they show children how to use new tools or materials? Do they guide students in taking more and more responsibility in investigations? Do they help students design and carry out skills or recording, documenting and drawing conclusions?
- **Supporting content learning.** For example, do they help students form explanations while moving toward content understanding? Do they introduce tools and materials and scientific ideas appropriate to content learning? Do they use appropriate content terminology, as well as scientific and mathematical language?
- **Using multiple means of assessment.** For example, are they sensitive to what children are thinking and learning? Do they talk to children, ask questions, make suggestions, share and interact? Do they move around and make themselves available to all students? Do they help children go to the next stage of learning with appropriate clues and prompts?
- **Acting as Facilitators.** For example, do they use open-ended questions that encourage investigation, observation and thinking? Do they carefully listen to students' ideas, comments, and questions, in order to help them develop their skills and thought processes? Do they suggest new things to look at and try and encourage further experimentation and thinking? Do they orchestrate and encourage student dialogue? (p. 82)

3. **How Does The Environment Support Inquiry?**
   Creating the proper environment is very crucial for sustaining an enquiry based classroom, but alone is not enough. An enquiry classroom may be very active and filled with materials and children having conversations about the subject being studied or it may be filled with evidence of independent investigations. The authors explain that there are three major areas of development in any enquiry classroom these are:
   1. Content and conceptual understanding and development,
   2. The skills and the activities of doing science and
   3. Attitudes and habits of mind.

   Walking into an enquiry based classroom, an observer may see that:
   - Students are working in an appropriate and supportive physical environment. For example, the room is set up to support small-group interaction and investigation, lists of student questions are prominent and available for all to see, a variety of general supplies are available, both at desks and in easily accessed cabinets and student work is displayed in a variety of ways in order to reflect their investigations.
   - Students are working in an appropriate and supportive emotional environment. For example, their thinking is solicited and honoured, they are comfortable expressing ideas and opinions and speaking up, they are comfortable interacting with one another and with the teacher and finally, they are encouraged to share information and ideas with each other and they know what they are doing and why.
   - Students are working in a variety of configurations and encourage communication. For example, work may be done in student pairs, small or large

> groups or in whole-class situations, students have many opportunities to respond to feedback and learn from one another and lastly, students become part of a "community of learning" supporting and affecting each other's thinking. (p. 83)

Adopted from materials created by the Exploratorium Institute for Inquiry.

Conclusion

All the different indicators mentioned in this paper is to assist school leaders and teachers in creating and sustaining a classroom and a school rich with an enquiry based learning environment. Although those indicators should be observed in an enquiry based classroom or school one might find that not every enquiry based classroom will look the same. In the full picture, the major elements identified may be seen in some form within the classroom. Ash and Kluger-Bell explain that "Inquiry classrooms always involve engaging children's intellect in exploring and investigating interesting phenomena. The emphasis is on allowing and assisting children to find their won best pathways to learning" (Division of Elementary, Secondary, and informal Education, Directorate for Education and Human Resources, n.d,p. 85).

To build on this paper, school leaders are encouraged to create a rubric using the indicators discussed in the section on Sustaining enquiry based learning environment. It is also advisable that more space it left for academic staff to modify the list to suit the school's vision and goals. School staff might consider adding other applicable and/or important indicators to the list of indicators and use it to evaluate enquiry based learning within classrooms and schools as a whole. I believe that creating and sustain enquiry based learning schools require a commitment from school leaders to reinforce and model enquiry to the rest of the school. Enquiry should be a school culture that ought to be practiced by both students and staff.

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