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Providing a Rationale for Promoting Argument-Based Inquiry Approach to Science Education: A Deweyan Pragmatist Aesthetics Perspective

Şevket Benhür Oral*
TED University, Ankara, Turkey

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Argumentation in science education is a well-established and successful research programme. Key theoretical underpinnings of this approach come from situated cognition perspective, the theory of communicative action and the sociocultural perspective, language studies and social semiotics, philosophy of science studies, and developmental psychology. In this paper, it will be argued that all these theoretical frameworks that aim to provide a rationale for promoting argument-based inquiry approach to science education stand to benefit if their unique insights can be brought together within the theory of Deweyan pragmatist aesthetics. It is my contention that learners first need to experience the most fundamental human situation, namely, the problematic as the ontological condition of experiencing the world as a human, in carefully calibrated pedagogically appropriate settings to get the process of collaborative inquiry going. One such setting is provided by the Science Writing Heuristic (SWH), an argument-based collaborative inquiry approach to experience negotiation of meaning in relation to science content in school. It will be claimed that the SWH approach, which is an immersion-oriented argument intervention model, is successful to the extent that it enacts a learning situation whereby the process of collaborative inquiry as understood by Dewey unfolds and provides a consummatory experience for the learners as well as the teachers.

Introduction

High levels of success in the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMMS) do not readily translate into skills in higher order critical thinking and scientific literacy (Nam, Choi, and Hand, 2011). Inquiry-based science education offers a much richer science learning experience than mere reproduction by students of scientific knowledge in textbooks (Chen, 2011). It dismantles once and for all the "notion of science learning as committing facts to memory" (Ford, 2008, p. 406) and brings forth a wide-open vista for students to learn science with understanding. By engaging students "in the activities and thinking processes of scientists to develop a conceptual understanding of the natural world" (Chen, 2011, p. 10), inquiry-based science education occasions a learning site where students *experience* science as a process of inquiry, and hence develop a deeper understanding and appreciation of how science works.

Understanding how science works cannot be separated from understanding how argumentative processes in scientific inquiry work. Constructing knowledge in scientific communities is ineluctably a social undertaking and constitutes an integral phase of the overall meaning-making process in scientific discourse. Teaching science as a process of inquiry therefore necessarily involves having students engage in argumentation to develop their understanding of how science and scientific communities work. In short, since argumentation is a constitutive part of doing science, it comes as no surprise to claim that it should be integrated into science education.

* Correspondence: TED University, Ankara, Turkey, e-mail: : benhur.oral@tedu.edu.tr

According to a review of argument interventions in K-12 science contexts by Cavagnetto (2010), this integration should take the form of *immersion*. Cavagnetto (2010) identifies three orientations to using arguments in pursuit of inquiry-based scientific literacy based on a review of 54 articles from the research literature. The *socioscientific* approach focuses on understanding the interaction of science and society to learn scientific argument. In particular, the "moral, ethical, and political influences on decision making in scientific contexts" (Cavagnetto, 2010, p. 349) are used to engage students in argumentation. Cavagnetto (2010) points out that socioscientific interventions largely zero in on "realizing moral, ethical, and political considerations associated with the application of science knowledge rather than argument for constructing an understanding of scientific principles" (p. 349). He further remarks that by their very nature socioscientific approaches tend to occur "in culminating activities such as class debates or role-plays" (Cavagnetto, 2010, p. 349), which, he argues, is one of the limitations of this approach. A second model Cavagnetto identifies is the *structure* orientation, where a generic structure for argument that can be used in diverse situations is explicity taught to students and they in turn are asked to apply this structure in scientific and sometimes socioscientific contexts (Cavagnetto, 2010). While Cavagnetto (2010) acknowledges that "[t]he interventions focused on the communication and defense of knowledge claims" (p. 351), he suggests that structure-oriented interventions offer "fewer opportunities for students to engage in other elements of scientific practice such as controlling variables, experimental trials, error, data transformation, and interpretation of data" (p. 351). In contrast to the socioscientific and structure approaches, Cavagnetto (2010) contends that

> the *immersion* orientation portrayed argument as a tool for both the construction and understanding of science principles and cultural practices (including discourse practices) of science. Immersion-oriented interventions were designed to embed argument within student explorations of science principles. That is, argument was not considered something that was done to conclude the inquiry but was found throughout the inquiry as students generated questions, designed experiments, interpreted data, and constructed and defended evidence-based knowledge claims based on their evidence. (p. 351, italics added)

Integrating argument-based inquiry approaches, esp. within the framework of immersion-oriented interventions, to science education is a worthwhile effort to promote meaningful and in-depth critical thinking and scientific literacy skills. The main goal of this article is to provide a conceptual grounding to why argument-based inquiry approaches actually work. Understanding why such approaches actually work is significant to refine the argument-based learning practices and afford solid support to their continuing promotion and development.

As can be evidenced from Cavagnetto's review, research in the field of argumentation in science education has attracted considerable attention in recent years and has become a well-established research programme. In an attempt to provide a rationale for promoting argumentation in science learning, Erduran and Jiménez-Aleixandre (2007) propose five interlaced perspectives:

- Supporting the access to the cognitive and metacognitive processes characterising expert performance and enabling modelling for students. This dimension draws from the situated cognition perspective and the consideration of classrooms as communities of learners.
- Supporting the development of communicative competences and particularly critical thinking. This dimension draws from the theory of communicative action and the sociocultural perspective.
- Supporting the achievement of scientific literacy and empowering of students to talk and to write the languages of science. This dimension draws from language studies and social semiotics.

- Supporting the enculturation into the practices of the scientific culture and the development of epistemic criteria for knowledge evaluation. This dimension draws from science studies, particularly from the epistemology of science.
- Supporting the development of reasoning, particularly the choice of theories or positions based on rational criteria. This dimension draws from philosophy of science as well as from developmental psychology. (p. 5)

Erduran and Jiménez-Aleixandre (2007) caution that these perspectives on why argumentation ought to be promoted in science classrooms point to *potential* dimensions that can be tapped into in classroom practice to achieve the outcomes laid out above. In other words, these dimensions need to be enacted. They do not automatically generate scientific literacy and the ability to think and reflect.

In this paper, I will argue, based on Deweyan pragmatist aesthetics, that in order to enact all these dimensions aptly summarised by Erduran and Jiménez-Aleixandre, firstly students need to experience the most fundamental human situation, namely, *the problematic* as the ontological condition of experiencing the world as a human, in carefully calibrated pedagogically appropriate settings. One such setting is provided by the Science Writing Heuristic (SWH), an argument-based collaborative inquiry approach to experience negotiation of meaning in relation to science content in school. The SWH approach is a prime example of an immersion orientation to argument intervention put into practice. In SWH, the argument intervention is considered to be an integral component of the entire inquiry process.

I put forth the idea that the SWH approach is successful to the extent that it enacts a learning situation whereby the process of collaborative inquiry as understood by Dewey unfolds and provides a consummatory experience for learners as well as teachers. To this end, in what follows, I will first discuss the basics of Dewey's theory of inquiry to provide a conceptual grounding to the argument. Subsequently, I will relate the Deweyan notion of inquiry to the framework of SWH to demonstrate how the latter instantiates the former and therefore provide a solid theoretical grounding as a complement to what Erduran and Jiménez-Aleixandre propose as a rationale for promoting the efforts of argumentation-based science education.

Dewey's Theory of Inquiry

In elucidating Dewey's notion of experience, McDermott (2007) highlights the constitutive importance of the problematic in Deweyan pragmatism in the following manner:

> The human organism, strikingly akin to other advanced organisms, transacts with the affairs of nature. The human organism, however, is paradoxical in that it knows whereof, whereat, and whereby this transaction takes place; in short, the human organism is aggressively self-conscious. This transaction between the human organism and nature is experience. The transaction is ever striated not only with problems, knots, but with the problematic as an ontological condition of being in and of and about the world. *To be human is to be constantly, ineluctably, irreducibly faced with the problematic*. (p. 415, italics added)

For Dewey, the world we find ourselves in is characterized both by stability, familiarity, orderliness, peace and quiet as well as disturbances, indefiniteness, ambiguity, confusion, anxiety, unknown and uncertain conditions. To quote McDermott (2007) again, "[o]ur lives are riddled with the presence of the tychastic and no probability theory, however sophisticated, will obviate the persistence of that strand in all we do. And Dewey is especially helpful in his denotation of the ever-pervasive rhythm existent between the stable and precarious generic traits of existence" (p. 235). For Dewey, this is not necessarily a lamentable situation. As a matter of fact, the rhythmic nature of stability and instability is the starting point of a genuine process of inquiry. Human

experience is meaningful only when we are faced with and reflectively engage a problematic situation in such a way that the experience had results in a heightened sense of meaning. If, as the philosopher Elizabeth Flower succinctly puts, "growth or development of selves, not attainments, is the primary educational goal" (Elizabeth Flower as cited in McDermott, 2007, p. 408), then we have to create learning situations wherein students experience a problematic situation as a condition to engage in inquiry to identify and address the problem at hand.

> In *Democracy and Education*, Dewey famously calls the aim of education, "growth." Growth is the development of habits of inquiry such that ordering and control of the traits of existence can occur for the purposes of deepening and enriching experiences had. We are to visualize this process as a circle; a circle in which meanings, patterns, concepts, propositions, techniques, and methods of inquiry lead to further, better experiences, and these further and better experiences lead to further and better meanings. (Johnston, 2009, p. 81)

In other words, the goal of inquiry is to develop better and richer experiences, hence growth.

Having established the starting and end points of Deweyan understanding of the human condition—namely, the rhythmic nature of stability and instability leading to the problematic as the ontological starting point of the human condition, and the capacity for further growth, that is, enhanced meaning and enriched experience of life as the end goal—I will now turn to what happens in between the alpha and omega points of the human experience. Concisely put, in between the problematic and growth, inquiry happens. But what is inquiry as Dewey understands it?

Dewey in his late tour de force *Logic: The Theory of Inquiry* defines inquiry in the following manner:

> Inquiry is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole. (LW12: 108)[1]

This is quite a dense and somewhat cryptic statement that needs to be unpacked to come to terms with what is at stake here. As has been mentioned before, according to Deweyan pragmatism, we live in a world that is at once precarious and stable. As long as we find ourselves in a state of equilibrium and harmony with our physical and social environment, we tend to contentedly carry on with the humdrum routine of our daily existence. However, such uneventful habitual regularity does not last for long. Sooner or later the state of well-being we have been enjoying gets disrupted for some reason or other. That is, things in the environment undergo change; and when change happens, that is, when we encounter a problem we do not know how to deal with (an indeterminate situation), we feel unsettled and are compelled to respond to it. According to Dewey, this is a precious moment for this is the moment when we have the power to respond to an indeterminate situation in a fruitful (reasonable) way: we *reflect*, that is, we take a step back and inquire into the problematic (indeterminate) situation to see how we can make sense of things again.

> Inquiry begins with an indeterminate situation. An indeterminate situation is unsettling, as Dewey maintains. Active investigation into an indeterminate situation begins and a judgment that this constitutes a genuine problem follows. The development of anticipatory consequences, that portend a satisfying solution,

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[1] Note on citations to Dewey's works: Standard references to John Dewey's work are to the critical edition, *The Collected Works of John Dewey, 1882-1953*, edited by Jo Ann Boydston (Carbondale and Edwardsville: Southern Illinois University Press, 1969-1991), and published as *The Early Works: 1882-1898* (EW), *The Middle Works: 1899-1924* (MW), and *The Later Works: 1925-1953* (LW). I adopt the following formula in referring to pages in the standard edition of his works: for example, "*Experience and Nature*, LW1: 18" means that the quoted passage is on page 18 of a book-length work comprising Volume 1 of *The Later Works*.

> is undertaken The aim in all of this is to reach a settled, determinate situation—a satisfying solution to the problem at hand (Johnston, 2009, p. 36).

Notice the rhythmic nature of this process. We start out with a state of well-being and unity. There is no cognitive discomfort. Everything makes sense. We know where we stand. We feel settled. Then, something happens in the environment and the equilibrium we have been unreflectively immersed in is disrupted and the disruption makes itself known. It becomes conspicuous; something we can no longer ignore starts bothering us. The situation turns problematic. One way to respond to this unsettling situation (the reasonable way) is to have a novel take on things. We take a step back and reflect on the situation, and not for the sheer fun of it. We are compelled to reflect, for we need to restore the equilibrium, to bring back the state of well-being into our lives again so that the world makes sense again. However, the old equilibrium is gone and it is not coming back. You cannot reverse the arrow of time. You cannot go back to the way things were for things have changed. A new equilibrium has to emerge, one that is more in line with the transformed situation, one that resolves the crisis of meaning, one that enhances the meaning of the previous phase.

Let me provide an example to illustrate how the rhythm of experience (integration-disruption-reintegration at a more encompassing and enriched level) unfolds. Say you are an accomplished high-school teacher with twenty-five-year teaching experience under your belt. You are pretty much set in your ways of teaching science to your students. You do all the right things in your classroom. You are well organized. You provide a variety of learning activities. You do your best to include all the students and try to incorporate activities that cater for their diverse learning styles. So, all in all, you are pretty content with your teaching and settled in your ways. You feel okay with your performance as a science teacher of twenty-five years (Phase 1 – sense of ease and contentment).

Then, one day, a distinguished university researcher contacts you and asks whether you would be interested to work with her in a National Science Foundation project to improve science education in K-12 schools. You are delighted and accept the offer. In one of the initial meetings with the research team, when the researcher asks "Are you confident that your classroom provides for the best learning possible for your students?" (Hand, Norton-Meier, Staker, and Bintz, 2009, p. 10), you realize that as a teacher nearing the end of his career, you have a nagging sense that something is missing. As you begin to learn about a new approach to science education (say, the SWH process), you feel unsettled and the confidence and surety you have been enjoying all these years get disrupted (Phase 2 – perturbation leading to reflective reappraisal, i.e., thinking).

How do you respond to this disruption? One option is to leave the project and forget about the whole thing and carry on the way you have always done. After all, what you have been doing in the last twenty-five years or so have served you well. You are still considered to be an esteemed colleague. You still receive outstanding teacher evaluations. There is really no need to change your ways. "Don't fix it if it is not broken." The trouble though is "it is broken." That nagging feeling has already begun working its way up your entire system. For Dewey, this is an opportune moment. Growth takes place when we feel compelled to reflect on a problematic situation in such a way that we move from the deep grooves of our entrenched habits to enacting new ways of seeing and doing things that enhance the meaning of our experience. As you work your way through the new model of teaching science, you are consumed by new questions and are revitalized to reconsider your old assumptions about teaching and learning and move towards a new understanding of science education pedagogy. The transformation is not instantaneous. It is a temporal (and sometimes torturous) process.

As you reach a more stable understanding of the novel approach to science teaching, you feel that the sense of ease and confidence is reconstituted to such an extent that you feel like a consummate teacher once again (Phase 3 – restoring the sense of fulfilment at a higher level incorporating and situating the prior teacher-centred practice in its proper place). You have gone through a learning

process and come out as a teacher more capable of creating truly student-centred learning environments. This is a consummatory moment, a moment of heightened and enriched sense of meaning. For Dewey, such moments constitute the essence of aesthetic experience, by which he does not refer to experience of art and art objects only. Dewey considers aesthetic experience to be the most fulfilling and complete mode of any type of experience, including everyday daily experience with its potential to turn into fulfilling consummatory experience.

What is important to notice here is that the rhythm of experience (settled-unsettled-resettled at a more fulfilling level) is not solely a cognitive process. To put it differently, the transformation in question is not merely a conceptual transformation. What is at stake here is the whole person and not just what is happening within the cognitive apparatus of the individual. The individual in his/her biosociocultural environment forms a transactional unity with that environment. What undergoes change is this unity. When there is some sort of perturbation in this organism-in-its-environment complex, the disturbance *is first felt* and then cognized about. According to Deweyan pragmatism, for the reflective phase of the rhythm of experience to kick in (the cognitive/thinking phase), the individual needs to feel in a pre-reflective fashion the qualitative change that is under way, i.e., s/he has to be involved emotionally. Having a sense of uneasiness is experienced pre-reflectively.

Thinking for Dewey is never merely a detached cerebral activity. Rather, it is embedded within a social situation, which is defined by qualitative wholeness. Qualitative wholeness is experienced pre-reflectively for we are immersed in it. We cannot simply step outside of it to have a secure handle on it. Our entire self-and-its-environment complex is involved in having a sense of equilibrium. The thinking phase of experience arises out of this qualitatively experienced situation (the transactional self-in-environment meaning-making complex) and after it has done its work returns to it with enhanced meaning. In other words, for Dewey, inquiry is enhancing the meaning of lived experience. For him, the cardinal sin is the separation of pedagogy from lived experience.

In his mature phase, Dewey focused in a more concerted effort on the aesthetic nature of the rhythm of experience and highlighted the significance of the consummatory phase (phase 3) of experience. In earlier work, Dewey had put the emphasis on the *instrumental* phase of experience (the cognitive/reflective phase) and was therefore misunderstood by many critics to be advocating an unadulterated scientistic conception of experience. The theme by which he is generally known, his "instrumentalism," has come to be treated paradigmatically and got disconnected from the way he most profoundly elucidated his understanding of experience and meaning in his later works such as *Experience and Nature* and *Art as Experience*, where he consistently made an effort to situate his theory of inquiry (instrumentalism) within the much broader concern of "experience" in its most complete, most significant, and most fulfilling mode—that is, experience as art (Alexander, 1987).

Alexander (2003) insists that "human beings experience the world as filled with meaning or value not primarily as the result of consciously deliberative or instrumental inquiry, but as a *qualitative whole of continuous interaction* that has the promise of *consummatory experience*. It is within this whole that instrumental inquiry itself takes on significance" (p. 134, italics added).

It is important to note that the culmination of the inquiry process and resolution of the problematic situation into an emergent more encompassing equilibrium, i.e., consummatory experience, is not the experience of a solitary being. For Dewey, humans are social beings. They are not first individuals and then social beings. Individuals "are not social atoms detached from social reality and contingent culture. Rather, they are *always situated selves*, that is, selves who try to make sense in what they do and say" (Reichenbach, 2002, p. 413, italics added) in a socially negotiated context. Inquiry is always a social practice.

Deweyan Inquiry and the SWH Approach

What happens in the case of the consummatory learning experience the veteran teacher undergoes (see the example in the previous section) also happens in the case of students learning science in a classroom. The rhythm of experience is not unique to adult learning only. It is a universal characteristic of *all* learning. In this section, I will attempt to flesh out, based on the discussion so far, the claim that the SWH approach to science education in schools is successful to the extent that it enacts a learning situation whereby the process of inquiry as understood by Dewey unfolds and therefore provides a consummatory learning experience for students as well as their teachers.

Let's begin by heeding the words of a science teacher about the utility of the SWH approach:

> What is so good about [the SWH] approach? Seeing students design experiments to answer *a question that they want to know about*. Seeing students who do not usually say much actually have an opinion that others listen to and think about. Seeing students research what others have done to answer a question similar to theirs. Seeing students express what they have found out with the written word. Seeing students discuss, argue, or debate points of view. Seeing students make connections with their world and the world of science. (Hand et al., 2009, p. 10, italics added)

As the teacher who has moved away from the traditional approaches to science teaching to more student-centred pedagogy attests above, the SWH is a classroom approach that exploits "the deep connections between science and writing" (Hand et al., 2009, p. ix). Basically, it is a method science teachers use to scaffold inquiry.

> The SWH approach was designed to create experiences for students to engage in science inquiry and to use language similar to the variety of ways scientists use multiple forms of language to describe, discuss, and understand their thinking. Not only does this approach build curriculum and understanding around students' prior knowledge and *their own questions about the topic*, the SWH is designed to promote classroom discussion where students' personal explanations and observations are tested against the perceptions and contributions of the broader group. (Hand et al., 2009, p. 14-20, italics added)

One common element that stands out from these two quotations is that the inquiry process starts with students' own questions about the topic. SWH does not start with learning about, say, the unit on ecosystems, by going over the content items, the list of facts, and vocabulary words in the textbook one by one in a linear order. The goal is not to stuff the minds (or brains, if you will) of the students with a string of words they can hardly relate to their own lived experience. The goal is to start with the lived everyday experience of the students (their prior knowledge and sense of the world they live in) and enhance the meaning of that experience by having them go through a self-initiated process of collaborative inquiry.

As a teacher, your task is not to make (push/force) your students engage in inquiry just because it seems to be the latest pedagogical fad. Your task is to introduce some sort of perturbation (a gentle urging/a dramatic encounter) in the environment of the learner so that the learner would feel compelled to address the disturbance in his/her understanding of the meaning of his/her experience. In SWH, this is done through determining the "big idea" of a given topic by having the students put together in groups a concept map representing their understanding of the big idea in question in relation to their own prior experience of the concept. This is not a simple sterile mechanical process taking place in a science lab in school. Rather, there is a dramatic and somewhat tensive encounter taking place between the lifeworld of the learners (their cognitive schema, if you will) and something that initially seems foreign—something that cannot be easily assimilated into their

existing framework (using Piagetian jargon)—to the texture of their lifeworld. This is the phase of inquiry when the learners feel puzzled and are invested in and excited about the prospect of examining their own thinking/sense-making process about the topic under consideration.

Students are not empty and passive vessels to be filled in with the wisdom and knowledge of the adults. They are live beings that are extremely sensitive about, cognizant of and constantly transacting (negotiating) with their physical and social environment. In their transactions (negotiations) with their biosociocultural environment, they experience meaning and they always try to maintain a state of well-being and equilibrium in terms of their understanding of the meaning of the world and their experience of it. Again, this is not merely a cognitive process. It is a whole self-environment process. The learner is not just a brain organized as a network of cognitive schema with a body externally attached to it so that the body acts as a transport for the brain to take it from point A to point B. The learner is a complex formed of the body-mind with its environmental correlates (physical chemical and biological as well as sociocultural environment). The learner responds as a whole, and not just as a brain (or mind). There is always a *feeling* component to this process. When we, as the teacher, introduce a conceptual disturbance of some sort to make a relatively stable situation unsettled, we need to be mindful of the fact that that disturbance is enveloped within the lived experience of the whole individual. It doesn't just register as a novel cognitive input. A good teacher is someone who respects their students as individuals who are capable of meaning-making transactions on their own terms based on their qualitatively experienced lifeworlds.

Once the first and most important phase of the rhythm of experience is initiated whereby an active investigation into an indeterminate situation in the form of questioning and mapping out "the big idea" begins and a judgment by the students themselves that this constitutes a genuine problem follows, "[t]he development of anticipatory consequences, that portend a satisfying solution, is undertaken … The aim in all of this is to reach a settled, determinate situation—a satisfying solution to the problem at hand." (Johnston, 2009, p. 36) In SWH what Johnston describes in a somewhat obtuse way is achieved through immersion in a series of student-driven reading-to-learn and writing-to-learn activities the goal of which is to enhance and enrich the understanding of the big ideas of science by having students engage in collaborative argumentation/articulation process that help them express and communicate their understanding of their own ideas in different forms of writing.

The dramatic encounter with "the big idea" in question, once successfully initiated through the skilful means used by the teacher, motivates students to understand the question more deeply. In this middle phase, the students have the impulsion to engage in intense dialogue with each other. They stay with the ill-defined situation trying to work it out to completion. This constitutes a tensive duration, a dramatic event unfolding over time where students begin to understand the connection between their initial ideas in reference to their consequences. They do not merely go through the motion of completing the tasks assigned to them. They are excited about developing, testing, comparing and justifying their ideas. For them, it is not merely a cognitive exercise. They are involved as whole individual beings collaborating with each other trying to make sense of a question they themselves have formulated. The middle phase is iterative and is meant to create opportunities for negotiation of meaning. This takes the form of a heuristic, which is

> a structure that helps students develop a deeper understanding of the big ideas of science. When considered in its entirety, students develop and test questions, justify their claims with evidence, compare their ideas with others, and consider how their ideas have changed throughout the process. At the conclusion of a series of SWH experiences focused on big ideas of science, students write about their learning not only to communicate with others but also in the spirit of a writing-to-learn experience. (Hand et al., 2009, p. 78-79)

The culmination of the SWH process does not constitute finality. The experience had is enhanced and the understanding gained is enriched. And this is a consummatory moment, an aesthetic sense of fulfilment. However, we have not reached completion, an end state of blissful satisfaction, where we have a complete knowledge of the topic at hand. No doubt there is a new sense of fulfilment and confidence. A new more encompassing equilibrium is achieved, i.e., consummation has taken place. A heightened sense of the meaning of one's experience of a given situation is attained, and this is tremendously joyful and gratifying. However, the situation is not a closed and finite system. It is always open to new disturbances. The drama is on-going. There will be new dramatic encounters. The transactional unity of the self-environment is a dynamic and emergent system. There will be novel experiences that need to be addressed. Consummation is not completion. It is being open to further inquiry for science is an open-ended process, so is science education based on inquiry approach.

Conclusion

There is ample research evidence that indicate that when implemented properly—that is, when argument intervention is carried out within the framework of immersion orientation—argumentation-based inquiry using SWH approach makes a difference in terms of student learning of science (Akkus, Gunel & Hand, 2007). SWH as an argument-based inquiry approach is structured in such a way that it provides a setting for the rhythm of experience in its interlinked phases to unfold in learners. There is no doubt however that it is difficult to implement such models in mainstream K-12 settings. I have argued that inquiry-based approaches to science education rest on solid theoretical grounds and it is worth pursuing such approaches despite practical limitations regarding quality of implementation, teacher training, and so on. Deweyan pragmatist aesthetics, where the consummatory phase of the rhythm of experience is brought to the fore, is one such ground. Argumentation-based inquiry turns out to be consummation-based inquiry.

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