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Perspective

"Science" and "art" as ways of knowing in school education in Nepal for an inclusive learning environment

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Received: 2 March 2023 / Accepted: 4 May 2023
Published online: 18 May 2023

Abstract
For several years, science and art have been viewed as separate entities in school education in Nepal. The dominant discourse on science was regulated by Western Modern Worldview (WMW), assuming that seeking universal truth should be the central aim of the exploration. In this article, science refers to the absolutist/rigid nature of different disciplines (such as Science and Mathematics) from the perspectives of Newtonian science, whereas art is viewed from three dimensions; literary arts (i. e. narratives, storing), visual arts (i.e., images, painting, sculpture) and performing arts (i.e., role play, drama). This paper argues that science and arts, as ways of knowing, should be taken as complements of each other. This literature-based argumentative paper also incorporates the lead author's experiences using art as/for pedagogical approaches in collaboration with schoolteachers. At the same time, the authors also argue the role of critical reflection to acknowledge both science and art as epistemology. The authors have used Dewey's perspectives on the roles of art for experiencing in education. Also, the notion of Mezirow's Transformative Learning is helpful as an influential lens to showcase the ever-changing thoughts in the transformation continuum. To set the context for the argumentation, the authors discussed the existing Nepali school education system, focused on curricula and pedagogical perspectives. The paper is helpful for teachers, teacher educators, and researchers to critically reflect on their own beliefs and practices in terms of viewing the different perspectives on STEM subjects and the inseparable relationship of science and art for knowledge generation and pedagogical application.

Keywords Science · Art · Critical reflection · Transformative learning

1 Getting into the issue

For several years, I (the first author) was engaged in applying well-established tricks, tips, and techniques as a mathematics teacher in schools and colleges in the name of universally accepted ways of knowing. I used hypothetico-deductive reasoning [1], believing knowledge can be developed through direct observation and experimentation. Following the same thread of arguments, I completed my master's dissertation claiming that the survey findings can be generalized for the population, which is the most valid way of knowledge generation approach. As I encountered different ways of knowing during my professional journey and conducted my M Phil and ongoing PhD research using various logics and genres, such as narrative, poetic, metaphor, etc., the old belief, *universally accepted ways of knowing*, turned into disempowering and inadequate. The deep-rooted beliefs about a particular discipline (such as mathematics is a rigid subject, mathematics can be learned through memorization) controlled my ways of thinking and valuing the knowledge system.

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When I realized that I was hegemonied by a singular way of knowing in education, I felt that I had to explore multiple ways of knowing and advocating change in the professional arena. Several questions arose in my mind, such as: what is knowledge? How do we generate knowledge? Why do we value a particular knowledge system? What constitutes values? What are the invisible forces that make a particular way of knowing "mainstream"? The ideas of the Western Modern Worldview (WMW) are grounded on a narrowly conceived view of natural science as objective evidence and scientific reasoning being the basis for establishing objective truth. Such truths are considered as universal, and timeless [2]. This mechanistic view of scientism does not account for the complexity science and quantum reality, thereby controlling our educational systems and processes as elements of a system informed by technical rationality. According to this scientistic view, material, object, and facts are incommensurable dichotomies and nature is subordinate to the triumph of human reason [3]. Such a view is insufficient in the education field in which teachers have to deal with complex scenarios welcoming context-based solutions and strategies in teaching and learning.

I felt that my teaching in secondary schools (grades 8–12) was guided by the notion of ready-made techniques and already-established ideas of providing training and teacher education. Given this context, the paper is the outcome of my ongoing PhD study, and the other co-authors are my research supervisors. The paper is developed entirely based on the first author's lived experiences as a teacher educator and researcher. The co-authors act as mentors of the first author in providing critical feedback and support during the development of the manuscript in a manner that designers and draftspersons work iteratively and nonlinearly. This paper explores the need to integrate science and art as pedagogical approaches in school education. More specifically, the paper also discusses the needs and limitations of scientific knowledge in school education. Art is taken as a way of knowing that complements scientific knowledge and vice versa. I have used the Deweyian idea of learning through aesthetic experiences in democratic practices as a major perspective throughout the paper. In addition, the idea of transformative learning by Jack Mezirow has been helpful in terms of promoting critical reflection to analyse the existing point of view in school education and welcome multiple possibilities to improve the educational landscape [4].

To address the aim, I began by elaborating on the theoretical lenses utilized to clarify the paper's primary themes. By studying the environment of education in Nepal, a subsequent part contextualizes the reasons for merging science and art as complementing instructional methods. As a mathematics educator for more than a decade, I then presented open versus closed visions of education, in general, using several instances from mathematics education. While working in the field of mathematics education, I advocated opposing restrictive conceptions of education and embracing open visions of education. I then continued to argue that scientific knowledge is insufficient, despite its necessity. I then examined the role of art in epistemology. Art as a method of instruction encourages students' critical and creative thinking. The essential premise of my thesis is that art and science are complementary. Consequently, I examined how these two concepts could complement one another. The Lila-Rita concept from Eastern wisdom traditions was examined. In developing internal mental processes with affection and values, I also brought the concepts of cognition and emotion, as well as the necessity for logic and creativity in education. Finally, I landed on the idea of critical reflection as a helpful way to welcome art as epistemology.

2 Theoretical lenses

I subscribed to the theoretical and empirical literature to establish the argument in this paper. I have used the ideas of Dewey as one of the orienting perspectives to argue the need to connect different disciplines with art. An important dimension of viewing art from the perspective of John Dewey (1859–1952) is the relationship between experience and learning. The process of creating art begins with a joyful absorption of the activity. People who do their work with care, such as artists, are artistically engaged, and learning becomes meaningful. Furthermore, Dewey argues that experiences should be educative when such experiences guide further growth, intellectually and morally [5]. The genuine experience should benefit the community. Another important aspect, as mentioned by Dewey, is democracy in education is a must to develop a thoughtful and active democratic citizenry. For that, establishing democratic practices at all levels of educational institutions is needed in a culture where the traditional education system seems hierarchical and inherently undemocratic. In the same direction, Dewey states that connecting experiences with learning and democratic participation could be seen while using different forms of arts because experiences are internally integrated with aesthetic quality [6]. According to Dewey, aesthetics and intellectuals should not be separated. Not only the philosopher of the last century but also a contemporary organization (i. e. The Association for Experiential Education), states that experiential

educators purposefully engage with learners in direct experience and focus reflection on developing skills, clarifying values, and increasing knowledge [7].

The notion of education as/for democracy [6] can be further broadened by Transformative Learning Theory [8]. Both ideas provide rich platforms for critical reflection on existing beliefs and ongoing practices and envisioning a better future in terms of learning and becoming. The work of Mezirow is beneficial to make sense of educational experiences with the world from subjective perspectives [8]. The notion of transformative learning theory is embedded in both communicative and instrumental learning. Regarding communicative learning, Mezirow states that it becomes essential for learners "to become critically reflective of the assumptions underlying intentions, values, beliefs, and feelings" ([4], p. 6). In this context, the four learning processes, as discussed by Mezirow, are useful. The first way, elaborating on an existing point of view, allows reflecting on the assumptions and values of education [4]. The second way, establishing a new point of view, creates spaces to critically reflect on the assumptions for better alternatives (could be the synergy of science and art). The third way, learning to transform the point of view, motivates people (could be teachers and teacher educators) to amend their beliefs and practices on teaching and learning. The fourth way, transforming the ethnocentric habit of mind (i.e., a belief that one's own ways of life are correct) by becoming aware of our generalized bias, helps teachers to welcome new insights and thoughts for reshaping their actions from both heart and mind. The reason behind our attempt to argue the inclusion of art and science as epistemic pluralism is based on two major premises; one is that there are numerous alternative epistemic systems, and the other is that no system is more precise than any other [9]. Being a citizen of a non-Western society, I have learned that there has been a gradual influence of neo-colonial thinking in education over the past few decades. In this context, transformative learning creates empowering spaces where alternative ways of knowing and becoming can be assessed. The ideas of transformative learning also apply in our educational setting, where the commitment to the changes has to be demonstrated in school education.

Trustworthiness (credibility, transferability, dependability, and confirmability) and authenticity [10] guided our argumentation in the paper. For credibility, we engaged with the research issues and site for an extended period of time and were involved in constant debriefing among co-authors. Transferability is maintained by supplying a detailed description of the contexts, allowing the findings to be applied to similar contexts. Dependability and confirmability are maintained by the consistent argument reflected through the rich opinions and experiences in the study. Fairness is maintained for authenticity in a context where the study's inquiry is value-bound.

3 Nepali education landscape

Even though recent efforts in school curriculum reform in Nepal appear to be moving towards inter-and multidisciplinary approaches in curriculum integration in lower grades [11], school education in Nepal has, for many years, focused on content-based teaching such as language, mathematics, science, and social studies. Such curricula primarily focus on the content-focused subject matter and discipline-focused pedagogical practices. Different subject matters are kept under different discipline-specific subjects in the Nepali education system, and different teachers are assigned to teach various subjects. Such curriculum can be equated with the image of *curriculum as subject matter* [12]. Curriculum practices are designed to prepare children fragmented by focusing on subject-centric knowledge and providing limited skills for tackling real-world problems. In doing so, the teacher is bound to teach the particular subject matters of her/his discipline in an isolated context. From the perspectives of students, on a single day, they have to cope with teachers of different disciplinary mind-sets, who usually believe that their particular disciplines are more worthwhile in life. Such seemingly different journeys that students should make in a day with different teachers may not provide rich learning experiences among school students. In such a context, students memorize pre-established ideas and demonstrate insufficient creative abilities, thereby producing a procedural understanding of the topic [13]. Only focusing on procedural understanding, which deals with the ability to execute action sequences (i.e., previously learned step-by-step solution method) to solve routine problems, does not support students in developing relational and conceptual knowing [14]. Several other studies (e.g., [15, 16]) have also pointed out that the Nepali school education system lacks relational knowing as it focuses on a fragmented approach to learning.

Connor et al. have indicated that teachers who purely deal only with the contents of their disciplines without being aware of the connection of their subject matter with other disciplines develop disciplinary egocentrism [17]. Pant et al. have argued that disciplinary egocentrism may discourage teachers and students from welcoming alternative ways of knowing [18]. In this situation, it is important for Nepali school education to challenge the disciplinary egocentrism way of thinking and move away from disciplinary practices toward a more multidisciplinary way of thinking.

Another issue of Nepali school education is the lack of practical skills-oriented pedagogical approaches. Here, the skills refer to the soft skills (also known as transversal skills and life skills), such as thinking skills, communication skills, and leadership skills, which are essential to adapt in today's complex social setting. The skills from a particular discipline and beyond are needed to solve real-world problems. For example, to buy an item from a shop near their home, children have to use various skills from a variety of subject areas, such as language skills, math skills, greeting skills, decision-making skills, and so forth. Our school education culture, as the "grammar" of schooling that celebrates the traditional structures and rules organizing the work of instruction in the name of standardized organizational practices [19], neglects to develop such a holistic perspective of skills that is essential in personal, social, and professional worlds. Perhaps realizing the importance of such soft skills in formal school-level curriculum, recently, the Curriculum Development Centre of Nepal has emphasized the need to incorporate soft skills in school education with a broader explanation in the curriculum [11], the impact of which is yet to be explored.

The issue of decontextualization is also a problem in Nepali education (especially in Mathematics and Science) [20]. In the name of "global" knowledge of mathematics and science, the local knowledge system is not acknowledged [21]. The idea of global has been misconstrued as scientific and modern systems that neglect implicit, local, internal, and artistic ways of knowing. It is extensively discussed that school-level mathematics and science have to be connected with cultural knowledge and practices [22, 23]. The cultural backgrounds of students are considered a strong bridge between students' cultural and formal schooling worlds. Along the same line, Orey and Rosa argued the importance of ethnomodeling to value the local knowledge system (especially in mathematics) for developing positionality and creating a dialogue with diverse cultural beliefs and practices [24]. Such cultural practices can be used as a *bridge,* as mentioned by Luitel and Taylor, by establishing a relationship among those different worlds to develop rich mathematical knowledge, which is largely a cultural construction based on culturally situated practices [25]. It is, therefore, necessary but may be challenging to incorporate culturally rich practices in school education due to the culturally decontextualized nature of the school curriculum in Nepal [20].

The current debate on curriculum integration (and thus in the pedagogical arena) has created food for thought for researchers and educators to welcome alternative ways of knowing. Slattery argues that academic disciplines are highly guided by positivistic (i.e. scientific) tendencies toward fixed categorization that lack the potential for multiple interpretive possibilities and assist students in viewing the world through new and diverse lenses [26]. In the same direction, Beane has argued for curriculum integration in which the curriculum design has to incorporate the significant problems and issues without considering much the subject boundaries identified by educators [27]. The ideas of Beane become powerful mainly for two reasons; one is due to the strong argument on the need to cross the boundaries of disciplinary segregation of knowledge, and the other one is young people (especially students) should be involved in the curriculum development process for whom it is being developed. Likewise, Barsky argues that ethics and values should be incorporated into an integrated curriculum [28]. The ideas of ethics and values are aligned with the ideas of an art-integrated approach in education; the details are discussed in the later section of this paper (see the subsection "Science and Art are Complementary").

According to Aikenhead and Ogawa, there are three distinct cultural ways of understanding nature [29]. One approach is indigenous, which could utilize the artistic way of knowing as it is based on myths, spirits, and ancestors. Another approach is the neo-indigenous way in which a concept is proposed for recognizing the unique ways, and many Asian nations use this way of knowing nature. Next, the Euro-American scientific approach considers science as a rational, empirically based way to explain and describe nature, partly based on descriptions and explanations. Nepal indeed has several indigenous practices, and indigenous ways of knowing should be placed at the center, but in the name of scientific knowledge, the Euro-American scientific ways of knowing have become dominant [30].

Summing up this section, the present scenarios (such as subject-centric curriculum, content-focused teaching, neglecting cultural artifacts and perspectives, and subordinating the importance of soft skills) in Nepali school education provide minimal space to interact among different curricular contents. For that, alternative views and perspectives need to be explored, and one of them is integrating different ideas and concepts to address real-life problems.

4 "Open" and "closed" vision of education

This section argues for the open vision of education in general based on the different ideas that have been historically discussed in the name of open and closed visions, romantic and formalist, and fallible and absolutistic nature of subjects and disciplines.

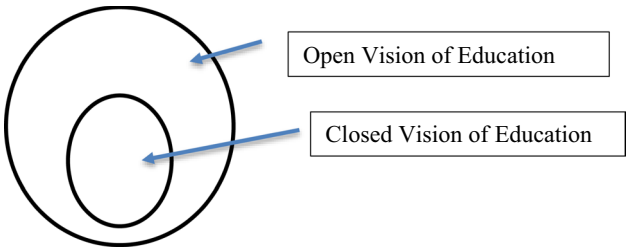
Greene argues that today's world, primarily guided by economic activities, demands vocational and technical training, which is necessary, but human imagination and the cultivation of new vision through the connection of art in the educational process is less acknowledged [31]. Thus, it's important to promote art equally. The focus on technical skills may lead to economic gain, but it fails to develop critical sensibilities of complex societal issues. Greene further elaborates that overemphasizing habitual work and routine practices does not welcome new perspectives on education in general and teaching and learning in particular. Imagination is needed for the openness of different societal issues such as gender discrimination, unemployment, and racism.

Another dimension of viewing the open and closed vision of education is the nature of subjects and disciplines. One of the foundational ideas is the absolute body of knowledge as the nature of subjects. I grew up believing that mathematical knowledge is unchangeable since my early school days. Once I started teaching, I spent considerable time promoting the view that *mathematics is a body of pure knowledge* [32]. There was always (and still is) an engaging debate among mathematics and science educators regarding the nature of knowledge. In the past, the Platonic idea was the most accepted view about the nature of reality. For Plato, (mathematical) statements and objects are mind-independent and abstract [33]. The Platonic view remained dominant for several decades; even today, that focuses on learning to receive abstract ideas that are mainly universal and perennial. In writing this paper, I witnessed the narratives of the Nobel prize winner in Physics in 2022, explaining Einstein's view as wrong [34] while science at its core is open; but its application in school education appears to be closed.

On the flip side of the coin, I realized that the non-Platonist picture of reality also exists. I wonder (how) it exists in the globe of different subjects. As my primary discipline is mathematics, I initially thought about how (mathematical) knowledge is beyond the Platonic view of knowing. Educators who started to search for different perspectives of knowledge, such as Lerman hold alternative views of the nature of mathematics [35]. The interaction with his texts was a point of departure in my professional context. He used the Lakatosian notion of quasi-empiricism as a theoretical basis to discuss the fallibalistic nature of subjects. Similarly, Ernest argues that mathematics is the product of social activities [36]. So, it has fallible nature that is corrigible and always open to revision. Such arguments challenge the deep-seated beliefs in the absolutist nature of different subjects and open the door for an "open view of education."

Another educator, Eisner states that there are two visions of education: formalist and romantic [37]. In the formalist vision, the curriculum and pedagogical approaches are taken as "rule-guided activities" that aim to achieve predefined goals, very much akin to the scientific paradigm of knowing. This view has been considered a "closed vision" where academic institutions and stakeholders do not have enough space to welcome new ideas and perspectives, such as curriculum as currere [38], and pedagogy as border crossing [39]. In the romantic vision, the invention of new ideas and perspectives emphasizes the discovery of already existing ideas for exploring human potentialities. In this form, the realization of new perspectives by welcoming new ideas, which may be unintended in several cases, is the central focus of imagination, which can be connected with art-based knowing.

A sincere attempt to explore the cultural nature of mathematics [22] and the open-ended nature of science [40] has developed sufficient spaces for developing an "open view" nature of different subjects and thus commenced the discourses towards a multi-dimensional view of the nature of different subjects, and pluralist ways of knowing. Moving ahead from two seemingly opposite natures of various subjects (absolutist vs. fallible), the discourse created by Luitel on "mathematics as an im/pure knowledge system" deconstructed the 'either-or' structure of the different nature of mathematics and helped to shape my beliefs towards an integral perspective [41]. In a similar vein, Maheux mentions that mathematics and aesthetics have a long common history and the Japanese aesthetic of wabi–sabi value includes imperfections, timeliness, incompleteness as well as a contradiction in the art [42]. From my experience, too, I realized that placing too much emphasis on the "pure" nature of mathematics has not benefited students or teachers and has resulted in poor performance in school mathematics. [43]. In such cases, using either pure or impure viewpoints may jeopardize the vision of inclusive and empowering mathematics for advocating 'glocalised' sensibilities among Nepali learners. For example, the recent attempt at the integrated curriculum of Nepal has included local numerals that are available in the different cultural and ethnic groups together with the international numeration system [11]. In this context, the space for promoting the local forms of mathematics (impure; informal, local, communal) and formalized mathematical knowledge (pure: algorithmic, abstract, formal, standard) could be a better alternative. The open vision of education also includes the closed visions and moves ahead, welcoming the ideas of local perspectives of knowing].

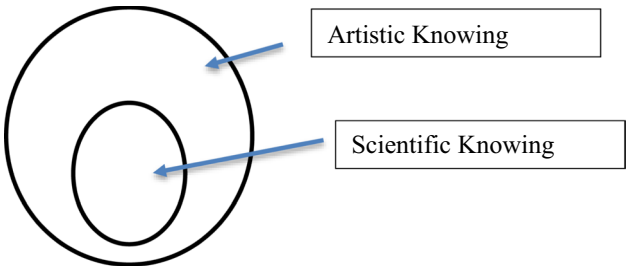


5 Scientific knowing is necessary but insufficient

Philosopher Thomas Kuhn, [44], has argued the process of scientific inquiry by carefully observing, developing a hypothesis, and testing the hypothesis as a part of "normal science". He further adds that we have to move towards a paradigm shift, where the underlying assumptions of the fields should be re-examined to welcome the newer paradigm. The foundation of modern Western science is materialism, which holds a belief that physical materials are to be considered as a major substance and that all mental states and consciousness are the product of material interactions. It believes that consumer goods and services provide the greatest source of satisfaction in life [45]. When the focus was on customer goods and services, the natural sciences that produce several goods to consume and provide better services came into the center of human discourses. In the modern era, the focus of the education system is also directed toward producing skilful human resources who can serve in the production and service industries [46]. Such an education system became popular in Britain and other countries under the influence of the British empire, as in the case of British-India. In the case of Nepal, we were influenced by the British-Indian Education system, and the focus on the "unquestionable nature of scientific facts", whose foundation is on materialism, has been dominant for many decades [41]. The scientific model is kept at the centre of modern education, where empirical evidence is considered.

The epistemology of the scientific model is based on the idea that knowledge is a universal phenomenon and can be produced through the pre-designed route. The notion of scientific knowing has guided several areas of research and teaching that have been the dominant discourses in the research tradition and learning theories for several decades. Scientific knowing is about arriving at objective facts through observations and experimentation [47]. While doing this, statistical relations of the observed phenomenon are established within the controlled environment. The doctrine of logical positivism (i. e. scientific knowledge is the only kind of factual knowledge) was the paradigm considered behind such a knowledge production system. Such a belief system is pertinent in the education process and system, making the entire education process follow the ready-made and "given" structure rather than acknowledging the multiple and emergent perspectives [48]. Such as, in curriculum development, for several years, the Nepali education system was guided by Ralph Tyler's curriculum development model, which is guided by the scientific management model [49]. Following the notion of the scientific management model of the curriculum development process, when it comes to pedagogical practices, teachers and students seek ready-made problem-solving strategies as tips and techniques rather than developing themselves as critical reflective practitioners [48].

As we move on, several movements arose to address the gap offered by natural science, which is necessary but not sufficient to address the complexities of today's world. Lakatos mentions that all scientific theories are tentative and open to revisions [50]. At the same time, different philosophers (such as Dewey and Freire) argue the necessity of careful transitions towards creative and imaginative knowing without completely denying the notion of scientific knowing.



6 Art as epistemology and a new form of pedagogy

Art has different perspectives. In general, art is taken as the manifestation of human creativity and imagination expressed in different forms such as visual, performance, and fine arts. Freedman argues that art should not be viewed in a limited sense for pleasure, rather it is an epistemology by which knowledge is co-constructed through visual investigations of complex ideas, such as virtue, environment, mistreatment, beauty, democracy, and violence [51]. In the argumentation of art as a knowledge generation approach in the education setting, Kaplan has mentioned [52]:

> We practitioners know that what they do with children in these early stages not only sets the tone and creates possibilities for future understandings, skills, abilities, and knowledge, but also, we know what we do is deeply connected to the ideas, concepts, and processes of art that students will encounter later in life and that our practices can be adopted and adapted into broader educational policy and practice. (p. 124)

During my teaching at the school and college levels, I have observed that art (such as poetry, stories, and painting) is rarely acknowledged in teaching and learning, especially in science and math. One of the possible reasons behind such a scenario could be the over-emphasis on scientific facts and scientific knowing since early schooling. The voices for integrating the arts in school have been getting louder in recent years. Several educators (such as [53, 54] have been working on art-integration in school education. One of the major arguments behind the integration of art is to create such learning environments that are aesthetically rich where children encounter wonder moments and imagine alternatives and feel pleasure and pride during learning [55]. Furthermore, an aesthetically rich environment always acknowledges multiple ways of knowing. For that, incorporating local stories, and students' paintings, and dramatizing the situation could be a practical point of departure in the subjects wherever possible.

Normally, students are encouraged to memorize the steps to be followed to get the "correct answers" to the routine problems that make students "machines" rather than critical human beings [15, 56]. Such deeply rooted problematic situations (i.e., students as machines) have neglected the interdisciplinary approach to knowing, thereby producing uncritical citizens. Eisner describes that individual responses to experiences are viewed as more valuable than attributes of objects in aesthetics [57]. The argument of Eisner is similar to the argument of Dewey, who argues that aesthetics is not a property of entities but rather the way one perceives and engages with things [58].

Here, I am also mindful that art is not separate from science and vice versa, Vico (1668–1744) explored the history and origins of humans in terms of language and myth. To discuss things, humans first create images before they form words. Vico contends that human beings are originally imaginative like poets rather than rational like philosophers. According to New Science, imagination and reason are closely related: civilized humans are rational, but they did not realize what they were doing when they became such;. like poets who pursue their imaginations above their logic, the early humans created institutions without reason. When this knowledge has been transmitted down from generation to generation, these so-called civilizers will be able to comprehend their actions. When this knowledge has been transmitted down from generation to generation, these so-called civilizers will be able to comprehend their actions. Several aspects of art require systems and methods that belong to science. Science versus art has been portrayed simplistically in curriculum development, pedagogical implementation, and assessment [59].

In the art-integrated education model, there are three strategies; first, all subjects are considered equally in pedagogy, content, and assessment; second, collaboration extends across the arts and general education, and

third, students are encouraged to immerse themselves in subjects through art [60]. Each of the above strategies is useful. The strategy that calls for collaboration between generalist educators and art educators manifests that arts should not be taken as a separate entity; art contributes to developing an aesthetically rich learning environment through collaboration with other disciplines. With art infusion, children can learn more than memorizing the routine contents and using pre-established methods to solve problems [57]. Students learn from such approaches by examining different perspectives on problems, generating meaning from them, and applying them to improve their understanding and competencies.

Critical pedagogy is another epistemology that promotes art-integrated learning. The arts are viewed as critical pedagogical tools, but, more importantly, as a means of exploring social issues [61–63]. Visual arts are popular among the public and have the power to explain social injustices and imbalances, which is one of the purposes of critical pedagogy. Critical pedagogy aims at developing critical consciousness that deals with an in-depth understanding of the world by questioning the deeply rooted values and assumptions behind certain beliefs and actions [61]. In addition to this, it also includes taking necessary actions against the oppressive components in one's life and the life of other people. Here, the argument is that the conventional scientific ways of knowing do not provide enough space for developing critical consciousness of any phenomenon.

Art is also taken as a public pedagogy [62]. Here, the term public aims for learners of different levels, backgrounds, interests, and abilities. For example, if schoolteachers develop and implement community-based projects, they make a strong connection between formal subjects of schools and out-of-school practices. Those contexts (projects) are always public, and they can lead to rich discussions in the learning process. Schuermans et al. have argued that public pedagogy is essential for social interactions by promoting the notion of living together in society [64].

There could be several entry points as there are different forms of arts, such as literary art, as epistemology could be the entry point, especially as a culturally relevant pedagogical tool. The incorporation of such culturally relevant knowledge into the school curriculum should enable the linguistic and cultural capital of a community to play a crucial role in the formal education of its children [65]. Welcoming arts as a pedagogical approach not only motivates students, but also focuses on an inquiry-driven approach that aims to investigate complex social realities rather than explore objective kinds of information.

7 Science and art are complementary

In this section, we argue the need to integrate two seemingly opposite ideas of science and art to complement each other and develop rich and authentic learning platforms. Ibarra and Sommerstad argue that art makes the invisible visible by using different forms of expression such as drawing, painting, etc., and art should be taken as a bridge to science and interconnectedness [66]. In both science and art, creativity is at the heart of each. But it can manifest in various ways. For instance, creating models in science may require a creative process. In teaching and learning science, creativity requires utilizing the various forms of arts appropriately. So, the growth and development of art and science were caused by finding ourselves in a world of puzzling ambiguities. We discuss several questions, such as what kind of planet we are on? Why are there night and day? What exactly is air? How do we think? Why do we create something? And so on. These are some fundamental questions that have led us to where we are now. Ibarra and Sommerstad mention that [66]:

> The methodology of artists and scientists often overlap. Both can be equally obsessive in their pursuit of results. Sometimes these experiments work, and sometimes they fail. But we never stop. My art is informed both consciously and subconsciously by the principles of science. There are many disciplines and theories involved in creating. Art theory has a mathematical correlation. (p. 153)

Making and understanding connections is another shared goal of both art and science. Based upon observation and understanding, human interconnectedness created societies and established shared values and ethics. It is through language that we are able to connect with one another. It is essential to express ideas. We want to be able to communicate our emotions and the fundamental conceptions of reality that we notice in our daily acts and envision in our imaginations. When we become more literate, we prefer more complex and incisive expressions. Despite an over-valuation of rationality, art provides both physical and metaphysical fulfillment to our human needs [66].

7.1 Lila–Rita dialectics

Lila–Rita dialectics is a powerful notion in the Eastern wisdom tradition, especially in Vedic traditions. The way of Lila–Rita can be an empowering idea to explain the inclusion of orderly routine activities (i. e. Rita) and unpredictable actions with chaos (i.e., Lila). Coomaraswamy argues that Lila can be explained as disorderliness, whereas Rita refers to the orderly actions which are developed out of a series of Lilas [67]. That means, Lila also includes Rita. The orderly activities are the output of several disorderly activities and chaos. Luitel has argued that knowledge production trajectory can use Lila for emergent activities and Rita can be understood as the order as the product of several forms of personal and professional Lilas [20]. Delving into the ideas of Lila-Rita dialectics of inclusion, the science-art debate can be understood where art-science collaboration is taken as the mother of innovation [68].

7.2 Cognition-affection blend

One of the ongoing debates in the educational landscape is between cognitive and affective ways of addressing educational phenomena by blending them in pedagogical settings. For several years, the cognitive science that deals with mind-based theories for the complex representation of ideas [69], cognitive psychology believes in the internal mental process of humans and memory patterns [70], and cognitive theory argues on the active roles of cognition for knowledge generation process [71]. Gradually, scholars (such as [72, 73]) contend that there are connections between affective domains (i. e. connection with emotions and feelings in learning experiences) and learning outcomes such as achievement, engagement, and participation. Zach and Rosenblum take the affective domain as a part of the human inner world that keeps relationships with others as an outer world for an individual's well-being and quality of social relationships [74]. Taber uses both affective and cognitive domains in designing educational objectives of Chemistry learning and concludes that the incorporation of both domains in learning makes learners feel challenged in the learning process and develop a metacognitive attitude to learning by inviting learners to take on more responsibility for their learning [75]. It shows that the conventional ideas of excluding such ideas should be welcomed with a principle of inclusion for the holistic development of learners.

7.3 Logic-imagination complementarity

For centuries, logic has been taken as the only way of ascertaining the truth and is the oldest intellectual discipline that justifies propositions based on the relationships among already established truths. Over time, logical arguments have been considered a major hallmark in school education by neglecting the roles of imagination [16]. But children imagining is also an important aspect of the educational process [76]. Once the educational system encourages imagination in education, it values contextual and unique aspects of learning. Beveridge argues that imagination is the source of inspiration for seeking new ways of dealing with the present and future [77]. At the same time, Beveridge mentions that it could also be dangerous if not exposed to discipline [77]. For that, critique and judgment are necessary for a productive imagination. In this context, both artists and scientists roam into the shade of the unknown until they find some useful ideas, thereby embracing the complementarity of so-called extremes.

The hyphenated relations of Lila-Rita, cognition-affection, and logic-imagination do not have to be seen in opposition. One contributes to the other, and both are necessary for an inclusive and rich educational platform. Science, normally, argues from the perspectives of Rita, cognitive, and logic. Lila, affection and imagination drive art. Both of these contribute to knowledge generation. Science is a self-correcting system that can be strengthened with imagination. The ability to think rationally and cognitively can enhance art.

8 Critical reflection as a gateway to welcome art as epistemology

As indicated in the previous sections of our writing, the present education system emphasized on narrowly conceived scientific knowing, which is necessary but insufficient. The overemphasis on scientific knowing produces technically skillful citizens but not critical and creative human beings. The present education system should not limit to only the workforce development paradigm. Rather, it needs to move forward to crafting critical citizens. In

this context, this section argues the need for critical reflection to welcome art at an epistemological level rather than as a tool for pleasure.

To produce inclusive practices in education, we need to adopt an inquiry-based approach to making educational practices more transformative. One of the important entry points towards transformative practices is *self-reflection,* where teachers examine their deep-rooted personal values and beliefs and question the assumptions about human potential and learning to envision better alternatives in teaching and learning [78]. School teachers typically expect easy-to-follow tips, skills, and techniques for solving routine (mathematical) problems [48]. For me, effective teaching entails much more than compiling skills and predefined techniques. For that, inviting students, teachers, and school leaders to reflect on their own practices is an excellent beginning towards transformation. Following the concept of self-reflection, as the next step of critical reflection, two concepts, self-reflection, and critical inquiry, are considered foundational [78]. Critical reflection has been discussed as a matter of stance and dance [79]. It is stated that stance is an inquiry that remains open for further examination, while the concept of dance as an encounter of risk and experimentation can always be revised.

Teachers seem to be trapped in their own deep-rooted beliefs that seem common in the workplace (such as mathematics is a culture-free subject) and make choices based on personal assumptions in the classroom. A belief system like this guides their classroom reflection and teaching practices. Teachers who believe that school mathematics is a rigid and absolutist subject prefer to follow the behaviourist teaching model. [80]. Hence, teachers and educational stakeholders need to practice critical reflection to become aware of their roles and responsibilities. Making reflective practice an integral part of daily practice is a good way to engage in it. Larrivee suggests maintaining reflective journals, which allow teachers to analyse the impact of their daily activities on the students [78].

Though engaging in reflective practices is essential for professional lives, it is not easy. I found an approach investigated by Larrivee for examining the core belief for making the strategies or moves for action in the teaching profession [78]. The first step for a teacher is to investigate the core belief system about life, and to assess the values, ethics, and religious beliefs of the students. The second step is to explore the framework for beliefs that are attached to the belief system assessed in the first step. Linking teachers' beliefs to the overall plan of action is the third step. Teachers develop daily practices and actions based on their core beliefs. Finally, teachers implement their plans of action via strategies and actions. These steps of examining the core beliefs are similar to transformative learning, as discussed by Mezirow, in which it is believed that individuals can change by changing their frames of reference by critically reflecting on their unexamined assumptions and beliefs and implementing new plans in their personal and professional lives [8].

Transformative learning enables students to implement multiple ways of knowing such as cultural self-knowing, relational knowing, critical knowing, visionary, and ethical knowing, and knowing in action [81]. Cultural self-knowing aims to understand our cultural selves, shared values and beliefs, the ways of being in our social and natural environments, and how they are formed. As an educator, exploring culturally situated values regarding pedagogical practices and making sense of those activities is crucial. Another way of knowing is relational, where teachers, students and other stakeholders engage in the learning process empathically and thoughtfully in culturally different communities. Such relational knowing develops affective sensibilities of culturally different people and places. Further, critical knowing enables an understanding of how and why the different forms of power (political, institutional, cultural) have shaped social realities by creating apparently natural and deeply rooted categories such as class, race, gender, etc. The most important issue is to explore how those invisible powers (such as science as superior and art as inferior) influence our life worlds as teachers, educators, researchers, and our relationships with other stakeholders. For that, critical ways of knowing would help. The visionary and ethical knowing provides me with enough space in creative, inspirational, and discursive processes to explore better opportunities in pedagogical innovations using different forms of art. While doing so, the awareness of our positions and limitations (such as being a member of visionary communities of teachers, students, and community members), and seeking the response for better institutional practice in terms of education and pedagogy is essential. In addition to this, to make visible changes in the community of practices, the idea of knowing in action, and expecting to make a difference in the community of practices by developing another level of awareness helps to create a better environment and a better place by taking the actions locally being equally aware of the global progress. Delving into the reflective practices could be a better option to assess the strengths and limitations of our thoughts and action and move towards inclusive practices by incorporating the different constructs in a holistic manner.

9 Conclusion

The necessity of integrating science and art in school education has been established in a number of ways. The discipline "science" has itself been developing through inquiry-driven approaches and the use of imagination. Later, when the scientific way of knowing came into existence around the globe through educational processes and systems, such knowledge systems were treated as though they followed a highly rigid and fixed structure and had no spaces for revision. In the same way, different forms of art are more than a part of human passion; instead, they constitute an epistemology to explore new forms of knowledge as emergent and open. Art can be an approach to establishing or reviewing (new) scientific knowledge, whereas science can be an approach to developing different forms of art. In this inquiry, we concluded that school education in Nepal should promote both science and art as ways of knowing and provide rich spaces for artistic knowing before establishing certain principles, relations, and consensus. These two ideas complement each other for a renewed understanding of our co-dependency with each other rather than neglecting the existence of other ideas. Art plays an important role in challenging conventional beliefs and integrity and advocates for change. For this, it is essential to reflect on one's deep-rooted beliefs and practices about the dominant ways of knowing to build an inclusive learning environment that welcomes science and art as complementary ways of knowing.

Author contributions The paper is the outcome of first author's ongoing PhD study, and the other co-authors are research supervisors. The co-authors act as mentors of the first author in providing critical feedback and support during the development of the manuscript in a manner that designers and draftspersons work iteratively and nonlinearly. Before submittting it, all authors reviewed the manuscript. All authors read and approved the final manuscript.

Funding This work is supported by the NORHAD Rupantaran Project at Kathmandu University School of Education, Hattiban, Lalitpur, Nepal (Grant number: NORHAD 2017–2023).

Data Availability On request, data used in this paper will be made available.

Declarations

Competing interests The authors declare that they have no competing interests.

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