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Content Analysis of Grade I-III General Knowledge Textbooks: Inclusion of STEAM Concepts

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Abstract- The purpose of this study is to investigate the extent in which STEAM skills are included in Pre-primary (grade I-III) general knowledge textbooks and curriculum proposed by Punjab Curriculum and Textbook Board (2019). Moreover, it investigates to what degree the textbook are consistent with the inclusion of STEAM subjects and concepts related to science, arts, engineering, math and technology. This study was qualitative in nature. Content analysis method was employed to analyze General Knowledge textbooks content to identify STEAM concepts. For this purpose, e-books of Punjab Textbook board was assessed and used. The content analysis framework was developed by reviewing the relevant literature of STEAM content and curriculum principles. The study revealed that STEAM is ignored concept at pre-primary levels (Grades I-III). The content and materials related to STEAM concepts are not included at each level. Only some of the content of basic level related to science and arts are included. The all five principles of STEAM Curriculum design proposed for pre-primary levels are not followed while developing the textbook. Concepts relayed to technology, engineering and math are totally overlooked and no link was created between arts, science, technology and related concepts. Therefore, it is necessary to update primary curricula in order to keep up with this international trend and address the growing need to produce innovative and creative minds as process and prosperity of country needs to rely on innovative talents of science and technology.

Keywords: STEAM, Creativity, Principles of STEAM curriculum, Innovation

I. INTRODUCTION

Tyalor(2016)said that all educators are striving hard to meet the challenges of 21st century to produce multi-literate workforce for knowledge economy around the globe. The world around us is changing rapidly, technological advances require a completely different workforce and countries must quickly adapt themselves to these challenges, otherwise they will be left behind in the global competition. Pakistan faces the dual challenge of addressing basic issues of education access and significantly improving the quality of education to compete in the global arena.

In this notion, Byrd (2019) said that United Stated of America (U.S.) particularly funded a lump sum amount in STEM project for the innovative curricula, professional development of teachers and related projects (U.S. Department of Education, 2018). However, low enrollment was observed in STEM education in the recent years. Therefore, incorporating arts into STEM curriculum emerged because of the every Student Succeeds Act, whole child learning, and a sincere effort to revive STEM. Whole child learning encompasses learning in and through the arts. Prestigious educational institutions and innovative STEM programs are introducing arts into STEM to create STEAM (Sousa &Pilecki, 2013). However, it is important to document whether the added arts-infused courses are, in fact, making an impact on student achievement by providing students with innovative STEAM learning or not. Different slogans and approaches are used across the globe to promote educational agendas i.e. Every Student Succeeds Act, whole child learning, and a sincere effort to revive STEM. Whole child learning encompasses learning in and through the arts across all curriculum subjects (Rabalais, 2014).

Fayer, Lacey and Watson (2017) reported as according to the Bureau of Labor Statistics, there were nearly 8.6 million STEAM jobs in May 2015, a total of 6.2% of U.S. employment. The U.S. Department of Education reports that the number of STEAM jobs in the United States will continue to grow, expected to increase 14% from 2010 – 2020. This is nearly three times higher than the national average of 5-8% across all other job sectors.

The Power of STEAM Education and Teacher Resource Availability. (n.d.) discussed that in recent times particularly in U.S the school districts and local governments are beginning to understand the importance of providing these skills to students in the classroom. It has become impossible to ignore this fact: students entering the workforce are arriving in a job market unprepared to deploy STEAM skills in a valuable and actionable way. There is no avoiding a STEAM topic when discussing the needs of the modern economy and workforce. Science, Technology, Engineering, and Math skills are becoming a requirement in industries ranging from manufacturing to finance and the soft skills associated with these concentrations play a part in nearly every sector out there today. Technology encompasses nearly every aspect of modern life. Having students become comfortable with STEAM fundamentals will have a positive impact on their future no matter which industry they end up embracing

Hogan and Down (2015) stated that It appears we need all citizens to be more confident and capable users of STEM knowledge. Most people will have to deal with a life where the specialist knowledge and skills that develops the innovations, the scientific claims, and the technological breakthroughs remains unknown and incomprehensible - even if not hidden inside the "black box". Nonetheless, all citizens are required to vote on issues that affect the environment, sustainability, technology, health, the economy, and planning. In this context, young people particularly students' need an education that not only prepares them extraordinarily well as future workers but as citizens capable of dealing with large amounts of information, making decisions and taking action for the future.

Furthermore, STEM is happening and changing in the workplace and industry in ways that school is not - and cannot - keep up with. In our view, students are far too isolated from the adult world and authentic forms of learning in real contexts. If we are truly serious about enhancing student engagement with STEM then it seems to us that schools have to find new ways of blurring the boundaries between school and community based learning around the big issues confronting society today. The essence of this approach is captured in the title of Washor and Mojkowski's (2013) book "Leaving to learn" which describes the benefits of out-of-school learning under the guidance of expert mentors. They argue that these kinds of experiences promote not only the physical, intellectual, emotional and creative energies of young people but deeper forms of learning. In the section to follow we argue that this kind of learning requires a fundamental shift in the ways our schools are designed in terms of structure, pedagogy, culture and relationships.

If we want to keep our eye on the big questions, the compelling questions of our times, the questions all young people are concerned about. According to the Chief Scientist (2013), the five most significant societal challenges that we presently face are:

1. Living in a changing environment
2. Promoting population health and wellbeing
3. Managing our food and water assets
4. Securing Australia's place in a changing world
5. Lifting productivity and economic growth (p. 5)

Central to this revitalized approach to education is student interest and the ways in which it connects to these bigger ideas. The irony is that young people are quarantined from the big challenges facing society, at least physically and we would argue intellectually and creatively. Therefore, this study aimed to find out the STEAM concepts incorporated in general knowledge curriculum at foundations years.

Previous studies have found that many children do not get the rich preschool STEAM experiences that could influence their school readiness and ultimate school success. The reason is that supports for STEAM activities are equally limited, educators spend little time in either curriculum design or activities.Textbook and Curriculum analysis is an effort to determine how effectively curriculum experiences and structure worked in educational settings implemented by officials. Analysis can be performed for different purposes in order to find out the commonalities and diversities (Houang, & Schmidt, 2008). As educators and researchers realize the importance of STEAM education, more and more countries are extending education from primary education to preschool education, such as America, Australia, South Korea, Singapore and so on. Relevant studies have shown that STEAM education in the early education stage plays a positive role in improving student creativity, innovation, engagement, problem solving skills, and other cognitive benefits, and in terms of improving teamwork, communication, adaptability skills for future career and economic advancement. Especially with the rapid development of science and technology such as the Internet and artificial intelligence, the process and prosperity of country needs to rely on innovative talents of science and technology.

Problem statement

As per National Education Policy Framework (NEPF, 2018) report that national level students' assessment surveys have, continuously over the years, indicated low mastery in science, mathematics and languages. This is perhaps due to lack of qualified subject specialist teachers particularly in mathematics,

science, and English across all provinces. An assessment of teacher's education degrees shows that there are less than 10% science and mathematics graduates in the basic education teaching force which leads to another dilemma of learning- teaching quality in Pakistan.

Currently, the education outcomes of Pakistani children as measured through a sample national assessment survey (2014), show that children perform far below the required national standards in all provinces and do not achieve minimum mastery of mathematics, reading, and language (as defined by the national government). This is directly linked to the quality of textbooks and instruction they receive in the classroom from the teachers.If more students are going to engage with STEAM then more students need to access an interesting STEM curriculum and textbooks.So, the purpose of this study is to investigate the extent in which STEAM Concepts and skills areincluded in Pre-primary (grade I-III) general knowledge textbooks and curriculum proposed by Punjab Curriculum and Textbook Board (2019).

II. LITERATURE REVIEW

Zinth and Goetz (2016) said that Education in science, technology, engineering and mathematics has captured the attention of state policymakers who are concerned about preparing students for an evolving workforce. By 2030, Institute for the Future estimates that 85 percent of the jobs that today's K-12 learners will be doing haven't been invented — demanding a workforce that is creative and prepared to respond innovatively to real-world problems. Including the arts in STEM learning can further enhance teaching and student achievement, and build upon existing approaches to STEM that encourage students to apply creativity to solving real-world problems. As a response to changing workforce demands, policymakers across the country are increasing their focus on the role of the arts in STEM and exploring opportunities to create and implement STEAM (science, technology, engineering, arts and mathematics) programs. This report highlights state policies and practices that can help states to increase student access to STEAM education.

Fayer, Lacey and Watson (2017) explained STEAM education covers a broad range of concepts and skills. From the most basic, which includes critical thinking and social interaction, to in-depth hard skills like engineering and coding, STEAM covers it all. There has been an incredible push over the past few years to incorporate STEAM education into classrooms. It has become apparent that these skills will be critical when students enter the workforce. Furthermore, careers and openings for positions specifically in Science, Technology, Engineering, and Mathematics are accelerating at an incredible pace. Preparing students for a world in which STEAM skills are essential, will be absolutely vital.

Further they explained that educators are the ones responsible for preparing the next generation for a world dependent on STEAM skills. Teachers thoroughly understand the core principles and fundamentals of STEAM education. However, it would be unfair to ask teachers to learn a new coding language or engineering and mechanics at any stage of their career. STEAM products can require an incredible amount of time and effort on the teachers' part in order to create lesson plans and incorporate them into the curriculum to meet state-required standards. Without meeting these important standards, these engaging products and resources are just toys.

The revolutionary step forward is the approach to how these subjects are being explored in schools. Project-based, collaborative and hands-on experiential learning are taking kids out of the textbook and proving to them with tangible experiences and understanding of how the skills they're learning will impact the world around them.

This approach represents a shift to an emerging ideal of education that values the process of learning in addition to the results. In STEAM education, students ask questions, experiment, improvise, innovate and solve real-word problems. Student learning experiences involve two or more standards from STEAM subjects, and the product of learning typically leverages the art form itself.

Six core STEAM education practices include:

1. Leveraging concepts in one or more STEM disciplines to create meaningful artwork.
2. Focusing on outcomes that have a personal and/or aesthetic meaning.
3. Conducting open exploration in the context of both science and art.
4. Designing with intention.
5. Iterating through several drafts, prototypes or models.
6. Communicating about the process and outcome.

STEM education has become a nationwide focus of innovation and entrepreneurial funding, as witnessed by industry-sponsored initiatives such as the 21st Century Minds (21CM) Accelerator Program, which aims to prepare children with '21st century skills' for the jobs of the future, including the ability 'to think

smart and creatively, solve problems, persist and take risks, have strong digital skills and know how to collaborate effectively' (PricewaterhouseCoopers, 2016).

Deloitte's (2015) report on the IT worker of the future argues that creativity is a key priority and that STEM educators need to embrace the arts in order to foster students' creative design and performance, using various media. Eisner (2008) explains that the arts are concerned with expressiveness, evoking emotion, generating empathic understanding, stimulating imagination that disrupts habits of mind and creates open-mindedness, and eliciting emotional awareness. In sum, the arts enable us to discover our humanity. Such an altruistic goal sits well with education for sustainability.The Sousa and Pilecki (2013) model of STEAM education acknowledged that arts have purpose in the development of students for life after high school. Sousa and Pilecki referred to brain development as being enhanced by arts exposure.

Given the rapid emergence of digital technologies, artificial intelligence, DNA mapping, robotics, nanotechnology, 3D printing, biotechnology and the 'internet of things', business and industry leaders are calling for graduates with liquid skills that enable them to adapt to a fluid working landscape throughout their lives; to prepare for jobs that currently do not exist, but that will be essential to the nation's economic wellbeing. Liquid skills include the ability to work with others, verbal communication, creative and critical thinking, active listening and active learning, and a disposition towards lifelong learning. These capabilities are deemed to be more important than high academic achievement for IT workers in the 'fourth industrial revolution' (Infosys, 2016).

Early research studies on ground-breaking STEAM curricula in the US have demonstrated that learning activities integrating science, technology and the arts successfully engage minority and disadvantaged students, resulting in improved literacy and numeracy competencies (Clark, 2014; Stoelinga, Silk, Reddy &Rahman, 2015). In WA, a science/mathematics teacher in a Big Picture school integrated stories about everyday ethical dilemmas into her Earth Science lessons and demonstrated that at-risk students engaged in ethical decision-making while developing scientific knowledge and inquiry skills (Taylor, Taylor & Chow, 2013).Though STEAM education is an innovative model, it is not a new practice; for more than 25 years, the National Science Foundation (NSF) has funded educational projects that integrate the arts and sciences (Davidson & Simms, 2017).

From a pedagogical point of view, Traditional lecture-style teaching and standardized evaluation cannot satisfy the experience of educators and children in STEAM activities [7]. This perspective ignores the process of children's exploration and creation, in which, the real-world problems and the meaningful applications are not reflected in the activities students are given [8]. If the themes of the activities are authentic and applicable to the real world, children's motivation and enthusiasm for participation will American Journal of Educational Research 486 be significantly increased [9]. Thus, the activity design based on STEAM curriculum can not only conform to the children's cognitive needs but also improve their comprehensive practical skills. The STEAM elements can be explained as follows: Science: Studying the world around usTechnology: Using tools to learn and work Engineering: Designing and building thingsArts: Making things attractive and engaging Math: Measuring things and results

Objectives of the study

The study has following objectives:

1. To find out the extent to which STEAM concepts are included in General Knowledge textbook of grades I-III.
2. To identify the content of STEAM concepts in General Knowledge Textbooks with respect to different subjects (science, arts etc)

III. Research Methodology

This study was qualitative in nature. Content analysis method was employed to analyze the content of general knowledge textbook of grades I-III. Researchers selected the general knowledge curriculum owing the importance of subject and its diverse nature. At pre-primary level, no spate books of computer, science, arts is used. The content of these subjects is covered by general knowledge subject. Content and activities suggested in text books of general knowledge published by Punjab Textbook Board for grade I, II and III were also analyzed to identify STEAM concepts.

Framework forContent Analysis

The framework for analysis of general knowledge curriculum in the present study was developed based on the technique of analysis of core curriculum advised by Levander&Mikkola, in their research

conducted in 2009. Present study analyses the pre-primary General knowledge school curriculum in two stages named as:
a) Concept Mapping Framework (CMF)
b) Dimensional Description Framework (DDF)

a) Concept Mapping Framework (CMF)

At the first stage of analysis researchers outlined principles related to design of STEAM curriculum by reviewing the literature. Mengmeng, Xiantong and Xinghua (2019) has identified five principles for the STEAM curriculum at Pre-Primary level. These principals are as follows:

Table 1.

Principles of STEAM Curriculum Design

Sr. No	Principles	Features
1	The Principle of Interdisciplinary Learning	Interdisciplinary learning means that teachers in STEAM education no longer focus on a specific subject, but on a specific problem, emphasizing the use of science, technology, engineering, art or mathematics and other interrelated knowledge to solve real problems
2	The Principle of Contextualization	Children learn differently in different situations, so that meaningful learning can only happen if it is embedded in The context of the application of relevant knowledge. So the teachers need to provide various real situations
3	The Principle of Interest	STEAM curricula should be consistent with the cognitive development stage and in the form of interest. For example, educators integrate elements, methods and frameworks of game into educational activities, so as to cultivate their interest in exploring activities, promote their scientific attitude and mastery of knowledge and skills, and lay a foundation for their hands-on practice and problem-solving ability
4	The Principle of Inquiry	Children actively participate in STEAM education activities and rely on their own direct experience to explore and find answers
5	Ill-defined Task and Well-defined Outcome	Implementation of STEAM education activities, teachers are required to throw out a specific problem and the goal to be achieved, but the way to solve the problem should not be overly restricted, leaving space for children to explore and find the answers

b) Dimensional Description Framework (DDF)

In this phase of analysis, the deepness of thought in the content and activates related to STEAM concepts was explored. The text description of STEAM concepts education was analyzed according to the suggested four dimensions in the framework applied in this study (Levendra&Mokkola, 2009). These dimensions are brief, explicit, extensive and implicit. Criteria for each dimension of description was developed:

• **Brief:** The description was taken as brief, if it consists of small number of words i.e. 5-15 words.

• **Explicit**: Description of aspect of STEAM concept was considered as explicit if it was explained by giving an example. The length of explicit activity and content may contain 10 to 15 lines or one paragraph.

• **Extensive**: Detailed description of aspect or idea was taken as extensive category of description. Extensive description might explain the one or more than one feature of STEAM concepts in one lesson. If an objective of curriculum thoroughly explained any feature of peace education that will be considered an extensive category of description.

• **Implicit**: Dimension deals with quality of description. If the description made the reader to think about the idea that description was considered implicit. Count of word may be less but idea discussed will touch the higher order thinking abilities. The description of aspect of peace education was considered comprehensive description if it is extensive and implicit.

In DDF researchers read the content carefully as outlined in CMF. The depth and quality of text was determined according to the set criteria in DDF.

Textbook Analysis

Aggarwal (2001) suggested some textbook features upon which the relevancy and adequacy of a textbook could be checked. Those are:

• Selection of Content: This consists of eight parameters that included the content must be relevant, adequate coverage of the content, enough content of each topic, authentic, up-to-date and integrated content and that content should be linked with daily life.

• Presentation of the content: Parameters to check the presentation of a textbook are appropriate and attractive title, motivating presentation, creative and interesting content.
• Verbal communication language: He further pointed out that the text book must be contained appropriate vocabulary, short and simple sentences correct spelling, correct punctuations
• Visual illustration: Illustration should be suitable for the mental level of the students, easily portable and up to date, motivate learners, relevant and purposeful, accurate, simple and cheap, and large enough for sight.

Analysis of General Knowledge (GK)Textbooks Grade I-III

General Knowledge Grade I-

This books has 23 small units covering basic concepts. This book is interdisciplinary in approach and covers content related to Islamiat, science, social studies particularly. GK-I is colorful and arranged keeping in mind the beginning level students. This book is visually attractive and language is clear and simple. At many places, instructions for parents are teachers are highlighted to teach the additional content related to the main concept.

Table II.

Division of STEAM concepts in Gk-I (Content and Activities)

Chapter	Activity Number	Page number	STEAM subject specific
Ch-1	3	3	Arts
Ch-8	2,3	18	Science
Ch-15	3	28	Math
Ch-16	1, 2	42	Arts

Analysis of Gk-I revealed that out of 23 chapters, only 4 chapters has content and activities related to STEAM concepts. There is no concept of technology, engineering introduced in any activity implicitly or explicitly at this level.

General Knowledge Grade II-

This books has 25 small units covering basic concepts. This book is interdisciplinary in approach and covers content related to Islamiat, science, engineering social studies particularly. Few topics are same as in GK-I but are advance in knowledge and understanding. GK-II is colorful and arranged keeping in mind the beginning level students. This book is visually attractive and language is clear and simple.

Sr. No.	CONTENTS	Page No.	Sr. No.	CONTENTS	Page No.
1.	The Blessings of Allah Almighty	1	14.	Earth's Resources	42
2.	Holy Life of Hazrat Muhammad ﷺ	5	15.	Agriculture and Animal Farming	45
3.	The Ambiya علیہم السلام and Character Building	8	16.	Constructions	49
4.	Rozah (Fasting)	11	17.	Conservation of Natural Resources	53
5.	Religious Festivals	14	18.	Helping Others	57
6.	Pakistan-Our Country	17	19.	Forgiveness and Forgiving Others	59
7.	Quaid-e-Azam (رحمۃ اللہ علیہ)	19	20.	All Human beings are Equal	61
8.	Our Flag	22	21.	Plants	63
9.	Neighbours	24	22.	Animals	70
10.	Neat and Clean Environment	27	23.	Water	74
11.	Cities and Villages	31	24.	Heat and Light	78
12.	Traffic Rules	34	25.	Our Earth	82
13.	The Government	38			

*Figure 3*Extracts from text book of General knowledge grade-II

Table III.

Division of STEAM concepts in GK-II (Content and Activities)

Chapter	Activity Number	Page number	STEAM subject specific
Ch-6	Ex. 2	17 &18	Arts
Ch-8	Ex. 1	23	Arts
Ch-10	Activity1	30	Science
Ch-12	Activity 1 & 2	37	Arts
Ch-16	Activity 1 & 2	52	Arts & Engineering
Ch-17	Activity	56	Arts
Ch-20	Activity	62	Arts
Ch-21	Activity 2	68	Science
Ch-24	Activity 1, 3 & 4	79 & 80	Science
Ch-25	Activity 1	84	Arts & Science

Analysis of Gk-II revealed that out of 25 chapters, 10 chapters has content and activities related to STEAM concepts. There is no concept of technology and math introduced in any activity implicitly or explicitly at this level.

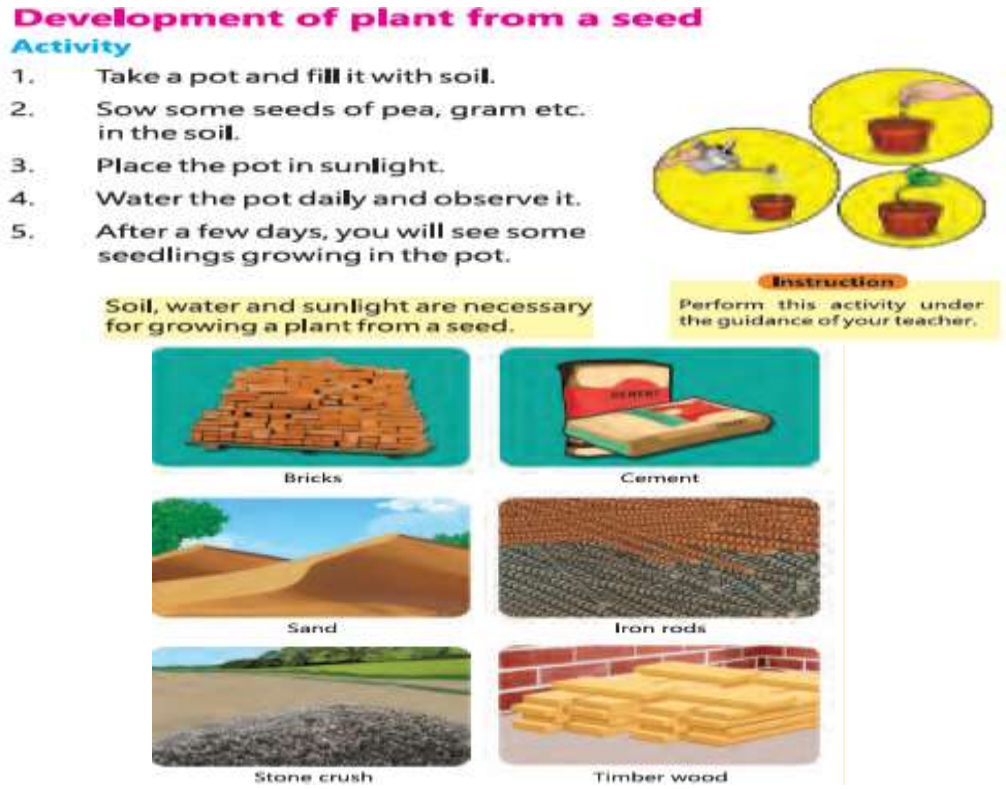


*Figure 4.*Extracts from text book of General knowledge grade-II(p.52 & 68).

General Knowledge Grade III-

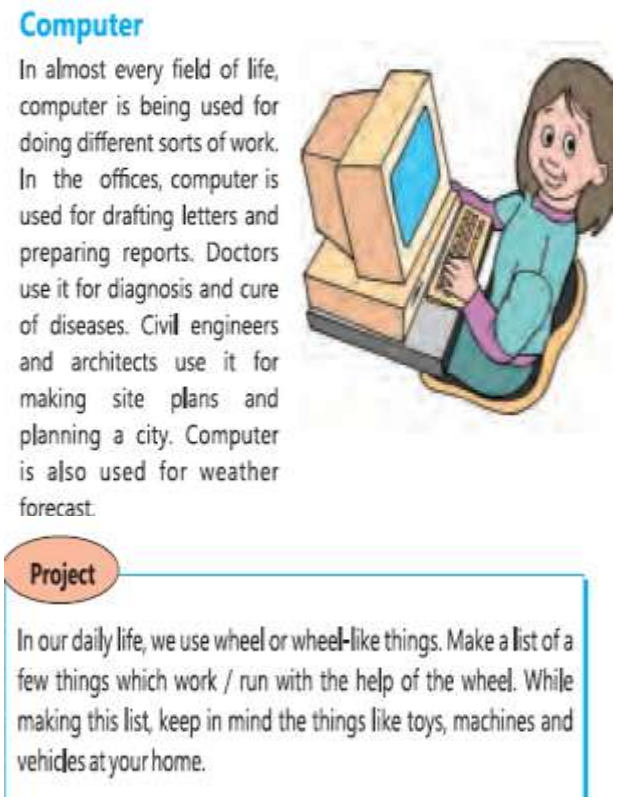
This books has 13 moderate units covering basic concepts. This book is interdisciplinary in approach and covers content related to Islamiat, science, engineering social studies particularly. Few topics are same as in GK-I & GK-II but are advance in knowledge and understanding. GK-III is colorful and arranged keeping in mind the beginning level students. This book is visually attractive and language is clear and simple. At some places, interesting information is also highlighted for the students and teachers.

Table V.

Division of STEAM concepts in GK-III(Content and Activities)

Chapter	Activity Number	Page number	STEAM subject specific
Ch-1	Activity1	7	Arts +Science
Ch-3	Activity1	13	Math
Ch-9	Project	40	Technology & Engineering
Ch-10	Activity 1	43 &44	Science & Math

Analysis of Gk-III revealed that out of 13 chapters, only 4 chapters has content and activities related to STEAM concepts. Introduction to computers (technology) and math introduced in one chapter explicitly at this level.



Computer

In almost every field of life, computer is being used for doing different sorts of work. In the offices, computer is used for drafting letters and preparing reports. Doctors use it for diagnosis and cure of diseases. Civil engineers and architects use it for making site plans and planning a city. Computer is also used for weather forecast.

Project

In our daily life, we use wheel or wheel-like things. Make a list of a few things which work / run with the help of the wheel. While making this list, keep in mind the things like toys, machines and vehicles at your home.

*Figure 6.*Extracts from text book of General knowledge grade-III (p.35 & 40)

IV. CONCLUSION &RECOMMENDATIONS

Textbooks are not addressing all the dimensions and diversity of STEAM concepts at pre-primary level. Missing elements of STEAM education are i.e. concepts related to technology, engineering and math must be introduced at each level and equal weightage should be given to STEAM concepts. Moreover, more concepts and materials should be incorporated at grade GK-I. Although textbooks of grade II & III has addressed some of the basic introduction of concepts related to engineering and technology activities were not mentioned based on these concepts explicitly. There is a need to include different examples, hand on experience, problem solving and logical thinking exercises and activities related to STEAM at different levels to make it interesting for young learners. As STEAM is the need of this hour, it is recommended to the concerned personnel's policy makers and content developers to develop content enriched with STEAM concepts and materials.

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