CHAPTER II

REVIEW OF RELATED LITERATURE

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2.0.0 INTRODUCTION

Review of Related Literature is an important part of research. As per Gay, Mills and Airasian (2015), review of related literature is the analysis of information related to research problem. It helps to determine what research had been done related to the researcher's topic. It gives insight to the investigator what needs to be done to justify the research study and suggest approaches and procedures for carrying out the investigation.

In this research study, the investigator had gone through review of literature related to science popularization. The researcher referred different e-resources, journals, books, research thesis and dissertations. Thus the research done across country and abroad was referred and the studies done on science education for community were referred in detail. The investigator glanced into objectives of research, research methodology and findings of other investigators.

The researcher came across 56 studies out of which four studies were conducted in India and 52 studies were conducted abroad.

2.1.0 REVIEW OF RELATED STUDIES

The researcher had reviewed the available related literature and classifying those into following five sub themes.

1) Researches on Science Centres.
2) Researches on Science Museums.
3) Researches on Non-Formal Programmes and Field Camp Based Experiences.
4) Researches on Informal Education Programmes .
5) Researches on Activity Based Educational Programmes.

2.1.1 Researches on Science Centres

The researcher came across 20 researches related to science centres which are given as follows.

Duensing and Jeanne (1999) conducted a case study on influence of Yapollo Science Centre in Trinidad in West Indies on local community. Interviews, group meetings and on-site observations were carried out. The study concluded that the learning in the science centre was seen as a social endeavor. The informal science museums and centres both reflect and create cultural contexts in which they were embedded. The study highlighted the role of non-formal educational approaches by discussing how science centre's informal educational approaches had resulted in dialectic with the local formal British based school system practice. The study explored the ways that staff had adapted exhibits and program idea from the international science museum. The synthesis of these cultures created its own cultural ways of thinking and practice about exhibits and pedagogy that formed the shared common wisdom at Yapollo. The science centre demonstrated teaching and learning practices which occurred in and reflected upon in multiple cultural contexts. The study focused on how cultural perspectives impact the science centre's sense of mission and design of educational programs.

Medved and Oatley (2000) carried out a study to know the impact of exhibits of Ontario Science Centre in Toronto in Canada that provide exhibits, interactive displays and demonstrations of scientific and technological phenomena. Data were collected from 50 exhibits that primarily focus on physical scientific concepts such as electricity, air pressure and sound waves. Total 39 persons were selected for interview. The study confirmed that the memories of visit remain vivid many years later. The additive effect of visual imagery resulted in better memory than verbal codes alone. About a third of participants' articulation of scientific principles did not change over the one month period. Another third of participants showed semantic memory deterioration. This was due to the fact that certain scientific concepts derived from signs and captions on the exhibits in the science centre remained available in memory for only a few minutes after

reading them when participants were interviewed. However, a month later, in another context and perhaps because conceptualizations which they had voiced to the interviewer had no firm schematic base to build upon, these memories were no longer available. Almost three-quarters of the visitors reported that once they had left the science centre, the exhibits were associated with some post-visit thoughts and behaviours. Though most visitors mentioned some type of integration, visitors varied greatly in the extent of their integration. For instance, the majority of participants discussed an exhibit with others. The behaviour such as reading an article about the exhibit topic or visiting the library in response to an exhibit was very rare. At the science centre, one month afterwards, virtually every interviewed visitor reported experiencing some type of emotion indicating that the affective connection to the science experience did not dissipate over time. Most participants reported enjoyment as their primary emotion followed by curiosity.

Sandifer (2003) conducted a study to know the interaction of visitors with a large ensemble of exhibits at two thematic exhibitions of symmetry and signals at the Reuben Fleet Science Centre (RFSC) in USA. Total 47 visitors were taken as a sample. It was clear that the characteristics of technological novelty and open-endedness helped account for the variance in the amount of time that exhibits held visitor attention. The visitors spent more time at exhibits with novel phenomena or objects in part because novelty was an important factor in intrinsic motivation and task engagement. They took advantage of open-ended exhibit activities.

Botelho and Morais (2005) had investigated the influence of exhibits and exhibit-student interaction on students' learning while interacting with two exhibits at the Knowledge Science Centre-Live Science in Lisbon in Portugal. The seventh grade students were selected as sample. The findings concluded that distinct parts of exhibits, essentially those related to the knowledge to be learned must allow students to easily associate them with the objects they are supposed to represent. The text in the exhibit label must contain words or expressions that help students to construct the relevant scientific concepts.

Sommerkamp (2005) explored the relationships between science centre exhibits and students' perceptions of grade 12 physics topics at Ontario Science Centre in Canada. The result showed that students had improved their understanding of physics after they were exposed to the interactive physics exhibits at the centre. The science centre supplemented formal science education within the school system. It stimulated curiosity in students which encouraged them to pursue careers in science, thereby ensuring that society had the expertise for future innovation and development.

Tlili et al. (2006) did the study to know the contribution of Westside and the Lowland Science Centres in United Kingdom in communicating science to the public. Total 10 staff members of these two centres were taken for the study. The study showed that science centre was a peculiar institution that occupied a minimal space and had multiple functions oriented towards disparate and sometimes contradictory objectives. The science centres tried to communicate the idea that there was nothing extra human about science that science was ordinary. The science centres' multiple mediating strategies reconfigured science as enjoyable, ordinary, relevant, instrumental, hands-on, non-authoritative and criticisizable. This was achieved to a great extent through making scientific knowledge secondary to a range of broader socio-cultural agendas. The pedagogy of relaying and relocating science found in science centres was even more markedly socialized than the pedagogy typical of formal education. This was to the extent that science centres tried to respond to and build on the expectations, pre-understandings and life worlds of multiple socio cultural constituencies. They had to justify their existence and role in positive social terms. Their survival and financial viability hinged on the interest and positive attitude of the socio-cultural groups that constituted the demographic field that the science centres invited as audiences and customers. However, science centres had a significant role to play in breaking down some of the distance between the lived experiences of visitors and those of scientists themselves by contributing to new constructions of science in the public imagination. They did so by more or less directly representing official science as a socially relevant, human, potentially enjoyable and contestable set of socio-cultural practices. The science centres had a valuable contribution to make to the reinsertion of

science into the public sphere. The science centres had great potential to resocialize and democratize science by submitting its claims to public communicative rationality.

Rennie and Williams (2006) conducted the study to know the learning of casual and adult visitors about science from their science-related experiences in free-choice settings. The research was carried out at an interactive science centre in Western Australia. The studies involved samples of visitors to an interactive science centre and attendees at a series of public lectures each given by an expert scientist in human genetics. The findings suggested that the educational role of free-choice settings should be considered carefully, particularly with regard to the representation of science. All people expressed high levels of interest in science and their interest was maintained through the visit or lecture. With regard to the nature of scientific knowledge, visitors to the centre arrived at the venue with moderately scientific views about the fallibility of scientific knowledge. But when they left, they thought that science had the answers to all questions that scientific explanations were definite and that scientists always agreed with each other. The visitors' perceptions about the benefits of scientific research changed little overall suggesting that there was no overall impact from their experience. Only visitors to the centre changed their views about the likelihood that scientific knowledge would be misused but the effect size was small. A general belief by many visitors and lecture attendees was that scientific knowledge would be misused. However, most visitors recognized that decisions in research involved ethics. The centre focused explicitly on making the learning of science and technology an enjoyable experience. The participants generally became more positive about the value of science, the work done by scientists and the scientists' ability to communicate with the public.

Davidsson and Jakobsson (2007) explored the different aspects of science that were displayed and the ways in which these aspects constituted different images of science at Nordic Science Centres. The research was carried out to know different aspects of science staff members displayed in exhibitions and constitution of different images of science. A web based questionnaire was sent to 88 persons and more than 75% (66 persons) answered. In all, staff members from 30 science centres participated in the

study. The results of this study pointed to two images that were mainly presented in exhibitions at Nordic Science Centres. The first image of science, technology and culture accepted technology as an important part of science in human context. A possible interpretation of this image was the intention of emphasizing gender issues and science from other cultures through a historical and technical perspective. The second image in future exhibitions was science debate. The third image, informative science, contained two aspects like 'scientific facts' and 'science in society'.

French (2007) conducted a research to examine Astronaut Training Centre at Science City in Kansas (USA) in order to identify specific behaviours associated with visitors' perception of learning and their attitudes toward space. The visitors to the Astronaut Training Centre were surveyed both during their visit and a year after the visit to establish their perceptions of behaviour within the exhibit and attitudes toward space and science. Observations of visitor behaviour and a survey of the Science City staff were used to corroborate visitor responses. 86% of visitors to Science City indicated they had learned from their experiences in the Astronaut Training Centre. No correlation was found between this perception of learning and visitor's interactions with exhibit stations. The visitor attitudes were generally positive toward learning in informal settings and space science as it was presented in the exhibit. The visitors also felt positively toward using video game technology as learning tool as it opened opportunities to develop exhibits using video technology.

Mathew (2008) did a study on the effectiveness of activities of Community Science Center in Vadodara (Gujarat) on school students. The objective were to know the impact of activities of centre for popularization of science among students, studying various methods adopted by centre for popularizing science and finding teachers, parents and science communicators' view on centre's activities. The study found that the centre's activities had a great impact in shaping the young students regarding science education. Students came to know centre's activities mostly through friends and relatives. Fifty percent of students were from age group 8-10 years. 36.67 percent students attended only science clubs while 33.35 percent attended both science and mathematics clubs. Students

preferred regular batch than a vacation batch. The students opined that the centre had good and systematic way of teaching than in a school. Teaching through doing experiments by themselves, practical work and learning new things in science were advantageous to students. Science concepts were well grasped by students after doing experiments. Parents said that child became more confident, active and interested by doing activities of centre. They wanted more promotional activities by the centre and practical knowledge. According to teachers, students got updated knowledge through centre's programmes. They suggested that there should be popular science lectures and film shows on science relation topic.

Makwana (2008) carried out a study to know the objectives, functioning in terms of administration, activities and facilities of Community Science Centre in Vadodara. The results showed that the objective of the centre was to disseminate the knowledge of science and technology to urban and rural fraternity, especially children. The centre popularized science through participatory learning, inquiry and experimentation. Science, mathematics, computer, astronomy and aero modeling club were formed for science popularization. Workshops, educational trips, science enrichment programme during vacation, school group visits, quiz and competitions, science project, model making, exhibitions, special event celebration were conducted by the centre. Lectures on science subjects were organized and the centre put emphasis on science education in rural communities. The centre published a magazine called 'Vigyan Vani' in English and Gujarati. The centre had infrastructural facilities like audio-visual centre, exhibition hall, technology hall, energy hall, life science hall, laboratory and computer centre. The centre was located in urban area of Vadodara and hence it mostly catered to urban community in comparing to rural community.

Davidsson (2009) did the research to know opinion of staff members of Nordic Science and Technology Centres (STC) in Canada on considering what scientific content to include when planning new exhibitions. The principal aim of this study was to explore what scientific content and on what aspects of science staff members focus when planning a new exhibition. Total 66 staff members from 30 different STCs participated in

the study. In the second phase staff members from 11 different STCs were interviewed. The results from interviews of staff members showed that they considered the scientific content of their exhibitions to a high extent in terms of organizational matters. The results implied that the relation between science and society risk being implicit to the visitors whereas the aspect of scientific processes tend to be overlooked when constructing new exhibitions. The staff members expressed an anxiety in displaying scientific uncertainties or different models of explanations arguing that this risks will confuse visitors. However, these aspects of science, in the field of science education, were considered crucial in order to create curiosity and interest in science. The respondents focused on what was possible to implement in limited exhibition areas whether the exhibit was considered to be enjoyable or what material was available for exhibit constructions. Some of the respondents state that the relation between the scientific content and what different aspects of science to display actually is unproblematic. However, most of the respondents tended to give implicit examples such as this relation was obvious to visitors because overweight and fatness was a societal problem or since the STC cooperate with local companies. A majority of the staff members argued that scientific processes were absent or implicit to the visitors in their exhibitions. Most common image displayed at Nordic STCs was the usefulness of science stressed applications of science in our society and excluded aspects such as scientific processes and controversial issues. The results of this study indicated that the staff members were aware of and had a broad understanding of science when it came to the nature of science, scientific processes and consensus.

Falk and Needham (2011) examined the impact of California Science Centre (USA) on public science understanding, attitudes and behavior. The samples were drawn from five racially, ethnically and socio-economically diverse communities generally representative of greater Los Angeles. The results suggested that the Science Centre was having an important impact on the science literacy of greater Los Angeles. More than half of residents had visited the Science Centre since it opened in 1998. Those who had visited believed that the Science Centre strongly influenced their science and technology understanding, attitudes, and behaviors. Most adults perceived that their children derived significant benefit from their experiences at the science centre. The parents reported that

their children learned new science was inspired by their visit to extend their science learning and that the Science Centre increased their child's interest, curiosity and attentiveness to science. The children were engaged in science-related activities following their visit. There was an indication, although weaker, that a visit to the Science Centre also changed children's behaviours related to science or technology. An important finding was that adults strongly agreed that the Science Centre created opportunities for them to talk with their children about science or technology and that it gave their child opportunities in life not supported by other organizations or institutions in the community. The Science Centre appeared to be primarily reinforcing and extending visitors' previous knowledge rather than adding new knowledge. Individuals who had visited this Science Centre were more likely to feel informed about science and this relationship increased with frequency of visitation. It was an important part of the public science learning infrastructure making a measurable contribution to the science literacy of a large number of citizens. A large number of adults who visited this Science Centre, including minority and lower income adults believed that it provided them and their children with important learning opportunities.

Daneshamooz et al (2013) had done a research on effect of Science Centre Of Science and Astronomy located in Khorasan Razavi in Iran on attitude of students those visited it. The sample consisted of 1002 students of grade 9, 10 and 11 studying in high schools. The questionnaire was given to students before and after the students visited the science centres. The result stated that the science centre improved the students' attitude towards science. There were significant differences between students in grade 11, 10 and 9. The science programs helped the students to increase in creativity, positive attitudes toward science and communication skills. Also, science centre experiences were enjoyable, leading to measurable increases in motivation and attitude toward science. It provided support to students in their learning process within formal education environments and in other facets of their lives.

Feinstein and Meshoulam (2013) carried out the research to explore in what way science centres in United States bridges the gap between understanding science and the

public. The other objective was to know about informal science education presented to which public. The informal science education institutes were selected by snowball techniques asking the participants to name other organizations that conducted equity work. The sample constituted 32 participants of 15 organizations like science centres, children's museums, aquarium and zoo. The research concluded that different informal organizations had made the science centres as per the suitable local culture. Informal science education organizations acted as a community liaison and building relationships with community groups. New exhibitions were created for diverse communities that they can identify with. The science centres held special events to attract broader range of visitors. The participants were skeptical about the long term impact of special events and exhibitions on the long term relationships between an organization and its community. The informal science organizations found difficulty of balancing the divergent needs and preferences of different group of visitors. Although several organizations tried to ensure that each exhibit could serve as many types of visitors as possible and responded to visitors differences. Pop-up programmes were done by the organizations which were aimed at children of rural schools where demonstrations and activities were done. The exhibits were shown at street fairs and community centres. The family workshops were conducted for science learning activities so that parents can also learn hands-on activities and deliver it to their children at home and other people of communities. There were capacity-building partnerships for staff training and development of educational materials.

Morentin and Guisasola (2015) conducted research on teachers' objectives during a school visit at Eureka Science Museum and Science Centre in the Basque City of San Sebastian in Spain. The research was carried out to know preparation of teachers for the visit, post visit activities and evaluation of the visit. A group of 158 teachers from 100 schools in the Basque country participated in the study. The results showed 56.3% teachers from primary and secondary education did not prepare appropriately for visit with their pupils. They did not use their professional pedagogical knowledge when organizing the visit. Only 5% of teachers presented activities attempting to connect the visit with the school curriculum. According to teachers, student learning was intrinsic to

the visit and that students themselves should make the links to the content studies in class.

Lelliott (2014) examined the knowledge construction processes involved when grades 7 and 8 South African students learnt about the concept of gravity while visiting a Hartebeesthoek Radio Astronomy Observatory (HartRAO), astronomy-related science centre at Gauteng Province in South Africa. HartRAO ran extensive science awareness programmes which concentrate on school visits as a form of informal learning. In the present study, the science centre formed a purposeful sample based on the astronomy subject matter knowledge it imparts to visitors. The classes from each of the three schools visited the science centre for two to three hours. The students viewed a slide show of the Moon landings and took part in a variety of activities which allowed them to experience the effects of gravity for themselves. A total of 26 students were selected for the interview. The study showed that most of the learning about gravity that takes place at HartRAO is limited and incremental, consisting of new facts such as the presence of gravity on planets other than the Earth, when the student had previously thought that gravity does not exist 'in space'. The study confirmed that the incremental learning of numerous individual facts was important when a school student visited a science centre. Furthermore, the study suggested that these facts were accumulated as a direct result of the visit with no intervention by the teacher. However, the study also demonstrated that some students acquired a greater understanding of the concept of gravity which involves more substantial cognitive restructuring. The visit to the science centre in the study appeared to result in previously learnt knowledge emerging from a student's long-term memory.

Şenturk and Ozdemir (2014) carried out the study to inquire about the effect of Middle East Technical University's Science Centre (METU SC) on students' attitudes towards science in Ankara in Turkey. The sample consisted of 251 students of sixth graders'. The age range of the students varied from 11 to 14. The results of this study confirmed that science centres had high potential on increasing students' attitudes towards science in all dimensions of the attitude scale except for 'practical work in school science'. This

increase was independent of gender, science achievement and grade levels. The study revealed that while METU SC had a positive impact on students' attitudes related to learning science in school, self-concept in school science, science outside of the school, future participation in science and importance of science, it did not have an impact on practical work in school science. One week after the visit, both boys' and girls' attitudes towards science decreased. However, girls' attitudes declined more than boys'.

Weiland (2014) did a study to explore Hispanic mothers' experiences as accompanying adults at an informal science centre in Southern City within the context of culturally sustaining experiences. This included the fluidity and plurality of cultural and linguistic diversity and support multilingualism and multiculturalism in practice and perspective for learners. Through a phenomenological approach, eight Hispanic mothers were observed with their children at a science centre and then interviewed to elicit an understanding of their experiences. The results indicated that mothers were largely unfamiliar with museums in general, yet the science centre supported their socio-cultural ways of learning and engaging with their children. Nevertheless, from the perspective of the mothers, opportunities exist for the science centre to provide more cultural/linguistic access to the exhibits. The results from this study suggested that this inclusive and affirming approach be extended to all informal science venues using a multi-modal approach to learning and should include cultural sustainability to support negotiations between prior and current cultural contexts. This could include, but is not limited to, targeted outreach and programming that values parents as intellectual resources and involving diverse community members not only in the design process but also in the operations of the centre. The science centre supported the mothers' personal and social context by providing them the opportunity to interact with their children in meaningful ways, specifically through dialogic inquiry. It has aligned with culturally sustaining experiences for Hispanic mothers with regard to its interactive hands-on, learner-centered approach that allowed for joint exploration and dialogue with family members. Furthermore, the mothers stated that they appreciated that the centre provided their children with opportunities to play in a manner different from that at home. Thus, the science centre's approach to learning and engagement was culturally sustaining with regard to the

mothers' own experiences and ideas of learning and play. The mothers stated that they valued learning by doing. The children did themselves by working alongside their parents and siblings. This approach to engaging in science was critical to inclusive education; however an inquiry-based approach scarcely addressed the complete framework of culturally sustaining experiences.

Falk et al. (2014) conducted an impact study on International Science Centre. This International Science Centre was a consortium of 17 science centres in 13 countries. The objective of the study was to determine whether experiences at science centres significantly correlated with improved knowledge and understanding of science and technology, increased engagement with science and technology outside of formal education and increased engagement within formal education system. An epidemiological approach was designed and questionnaire was developed for each of the 17 communities with a sample of 5792 youths of age 14 to 15 as well as 6089 adults of age 18 and over. Total 44% in the combined sample had visited one of the science centres at least during their lifetime. The research concluded that youths and adult increased the knowledge and understanding of science and technology. The science centres increased the curiosity about science and technology and engagement with science as a school subject for youths.

2.1.2 Researches on Science Museums

The researcher came across seven studies related to science museums which are presented as follows.

Rix and McSorley (1999) explored the role that a school based mini-museum in United Kingdom designed to mimic an interactive science centre for young children's science education. The research investigated children's interactions with exhibits and each other and suggested that although children did appear to make some gains in their learning of scientific knowledge and scientific skills and processes, the largest gains were made in the development of positive attitudes towards science. For the purpose of this study, two

groups of seven year grade 5 stream children were formed, each having slightly different experiences of the museum. A third group of six year 5 'A' stream children were also included in the study where science centres provided children with the opportunity to develop their existing ideas through discussion. This research had indicated that though children did not seem to interact with the exhibit in a systematic manner, they used scientific skills and processes to some extent. They did not know the operational methods and the reason behind the working of the exhibits. The analysis of the post-experience survey highlighted the success of the mini-museum in terms of the children's enjoyment of their visits. This enjoyment also appeared to have produced an improvement in the children's attitudes towards science. This positive attitude towards science provided the classroom teacher with opportunities to build upon the children's new-found enthusiasm and to ensure that they made lasting gains from their interactive experience.

Rivera and Dian (2002) conducted a study to know in what way learning of science at a science museum impact adolescent motivation. The respondents were asked what motivates middle grade students to study science at a science museum and how these activities benefit in the field of science education. The participants were eight grade students enrolled in a NASA (National Aeronautics and Space Administration) funded science program called SEMAA (Science, Engineering, Mathematics and Aerospace Academy). The results indicated that studying science was a fun, career oriented, competitive and hands-on.

Melber (2003) conducted a study to know the impact of a museum science program on students. The program focused on inquiry-based activities which museum scientists used to do. The research concluded that students understood the science as a way to make a career in it. The knowledge of students related to science and the working methodology of scientists were understood by the students.

Suzuki (2005) conducted a study to know working of informal institutions like North Carolina Museum of Natural Sciences for science popularization USA. The staff members of the museum and the visitors who visited it were taken as sample. During the

posted time, 42 administrators, 21 exhibit developers and 36 program planners responded by completing one or more surveys. The institutional survey found that most institutions focus on attitudinal reinforcement rather than visitor learning. They did not overtly value research or long-term assessment and value partnerships with schools more than other groups. At the same time, the staff did not have a clear vision of the nature or function of an operation manual. Large gaps were found between the actual and desired states in terms of assessment (administrators, exhibit developers, and program planners), professional development (exhibit developers and program planners) and partnerships (program planners) indicating that their current visions and attempts were not consistent and needed improvement. Staff professional development sessions must include acquisition of assessment skills and general knowledge in science and science education. For all responding groups, administrators, exhibit developers and program planners, their goals of the operation focused more on providing resources and activities and less on guiding and helping visitor learning of science. This result implied that the institutions prepare lot of learning materials and activities and it was left to visitors what to choose in their museum visit. The current focus of informal science educators tends to be on visitor enjoyment, curiosity and visitor understanding. The informal science staff used ideas from colleagues and the results of internal evaluation when designing activities. This and the results of the actual state of assessment mentioned above implied that their activity design was based on attitudinal reinforcement and they did not emphasize visitor learning much. The need for professional development sessions was high among all responding groups. The science teachers who applied for the lesson expected their students to learn science more broadly beyond the wall of schools and learn in a friendly atmosphere while working with museum staff.

Meisner et al (2007) examined the use of novel computer-based exhibits to explore how people interact with and around the installations at the Energy Gallery at the Science Museum in London. It was a computer-based exhibition designed to facilitate engagement and discussion of socio-scientific issues by engendering a variety of forms of activity with and around the exhibits. The gallery was mostly targeted at a school-aged audience but also catered to public also. The data, including the video recordings, field

observations and discussions with staff and visitors had been gathered for the study. The data were drawn from video-based field studies of the conduct and communication of visitors to the museum. The study explored how visitors transform their activity with and around computer-based exhibits into performances and how such performances create shared experiences. It revealed how these performances can attract other people to become an audience to an individual's use of the system and subsequently sustain their engagement with both the performance and the exhibit. The visitors created elaborate and embellished actions with and around the exhibits and activities that can be characterized as "performances". Such performances are produced in the moment at hand. The "performers" not only used the exhibits but also created engaging and enjoyable experiences, both for themselves and those observing them. Because the exhibit was designed to be open on both ends, people often passed through the gallery and even the exhibit without noticing it. Yet, when the exhibit was occupied it drew the attention of individuals who happened to be simply walking past. Childrens' embellished actions, their audible clapping and gross gestures in front of the large screen were produced to play the game. However, such activity also kindled a stranger's interest in the exhibit and thus generated an audience to the activity. The children's actions provided their audience with an understanding of both how the exhibit worked and what it might be about. The activities drew individuals, including complete strangers, to an exhibit and allow them to observe how others engage with and respond to the exhibit.

Stroud and Sewand (2008) examined the role of attitudes toward science, knowledge of science and participatory learning in an astronomy internship for high school students in a museum. In the first study, four aspects of attitudes toward science were investigated. The results revealed that interns held mixed views of themselves as scientists, held positive attitudes toward science for four primary reasons and provided twelve reasons for their pursuit of science activities outside of school. In the second study, four aspects of scientific knowledge were investigated. The majority of interns believed teaching was part of the scientific enterprise. The amount of depth of science content learned during the internship depended on interns' prior knowledge and was learned during three specific aspects of the internship. Finally interns used numerous science concepts during

the internship. In the third study, six aspects of participatory science learning were investigated. Interns found teaching to be the most salient aspect, viewing it as an authentic practice and a path of science learning as well as providing a sense of ownership in their practices. Interns created a unique community within the internship combining aspects of the pre-established museum educators' community of practice and an internship-centred activity group.

Tomoko and Masakata (2014) studied the nature of life exhibition content among Japanese science museums from the viewpoints of Japanese indigenous understanding of Shizen and contemporary life sciences. The study aimed to know impact of different aspects of natural world (Shizen) and contemporary life sciences to cultivate scientific minds among the public. The findings showed that educational missions in natural history institutions appreciated and reflected Japanese indigenous understanding of Shizen in addition to having a scientific understanding of life phenomena. From the Japanese Shizen perspective, life exhibitions in Japanese science centres and museums included ideas derived from an indigenous understanding of Shizen in the context of the relationship between people and the natural world. The exhibitions on the regional natural environment (for example, regional flora and/ or fauna) seemed to represent both the Shizen and a life science perspective simultaneously.

2.1.3 Researches on Non-Formal Programmes and Field Camp Based Experiences

The researcher came across 10 research studies related to non-formal and field camp based experiences which are presented as follows.

Vasava (1998) carried out a study on the enrolment, functioning, supervision and monitoring in non-formal education centres in Vadodara district. The findings revealed that girls were not interested to enroll at the centres. The teaching materials were not provided in time while the teaching of instructors was also poor. The instructors and supervisors were not satisfied with their payment and work load was also very high for them. There was continuous training of the teachers at centres by resource persons and

the teachers suggested that the duration of training should be less. The centres lacked sanitation and recreational facilities.

Kuo and Pi-Chu (2005) evaluated the effectiveness of an American science camp for Taiwanese high school students in terms of student attitudes toward science and to understand the factors that affect student attitudes toward science in the American science camp. The study was done to know the impact of the science on student attitudes toward science. The results from the comparison between the two science camps showed that different program designs had different impacts on student attitudes toward science. Science camps motivated students' interests in learning science.

Ricks (2006) conducted the research to know the impact of Summer Science Camp (SSC) on students in Texas (USA). SSC is an informal summer science education program for 7^{th} and 8^{th} grade students residing in Galveston County, Texas. The SSC program curriculum was designed to enrich students' science knowledge by engaging them to hands-on science laboratory-based problem-solving instruction, scientific experiments, field-trips and other STEM (science, technology, engineering and mathematics) related experiences. The study was done to know the effect of the informal science enrichment program on participants' science knowledge achievement, participants' attitude toward science and participants' selection for advanced STEM courses in high school. The outcomes of this study suggested that the innovative hands-on learning activities, problem-solving experiences and opportunities for reflection conducted in this informal scientific setting were important elements for students' meaningful understanding of science concepts. The informal program was important and recognizable forces that impact students' science learning, science attitudes, interests, and decisions.

Votaw (2008) conducted study to examine the impact of a ten day informal learning immersion science camp in USA had on urban, low economic status middle school students and teacher-leaders. The students were incoming seventh grade students involved in a community based scholar program designed to recruit and support socio-

economically disadvantaged, academically talented students. The teacher-leaders were professional educators working toward an advanced degree. The purpose of the camp was to immerse the students in informal learning environments that affect their daily lives. The students and teacher-leaders visited facilities that provided public utility services like power plant, sewage treatment facility, zoo, forest and arboretum. The results showed that students' content knowledge was enhanced and expanded through the learning of factual knowledge as well as understanding of the importance of broad scientific processes. The students developed an awareness of the natural world and a foundation for future learning. They developed an awareness of science as it applied to their own lives. The attitude of students toward science was positively impacted through development of an increased resource appreciation, positive social experiences and experiential sharing with others. Teacher-leaders reported that they got a value-added experience for their teaching. The teacher-leaders enhanced the understanding of science principles.

Preusch (2009) had done the research to know understandings of the student process of learning during and surrounding an environmental science field trip to an outdoor setting in USA. The purpose of this case study was to develop an understanding of the experience and process of learning by a fourth grade teacher and her students surrounding a field trip to an outdoor environmental science education site. During the field trip, the students' active engagement with each other and the environment supported meaningful remembrances of the field trip experiences during interviews after the field trip. The students accurately described plants and animals they had observed in different habitats during the field trip. They also made connections with their home life and prior experiences in the outdoors as they discussed the field trip and drew pictures that represented their experiences. After the field trip, the students made connections with their home lives. They mentioned their prior experiences watching nature shows on television and playing in and exploring the outdoor environment around their homes. The students' interactions with the site educator were consistently energetic and responsive. The students responded actively as they participated in a variety of activities that involved interactions with others and with the environment during the field trip.

Riedinger (2011) had done a research to know about the role of conversation in influencing middle school science learner identity development during an informal science education camp. The Coastal Ecology field trip program offered at the Marine Science Consortium in Wallops Island on the Eastern Shore of Virginia (USA) was selected as a case study. The result showed that the learning conversations played a role in developing participants' identities as learners of science. These unique features of the science camp program included a focus on affective dimensions of learning, access to science tools, a supportive environment, authentic science activities and novelty. The participants learnt about marine ecosystems and the environment. The science learning activities during the camp program focused on providing participants with fun and motivating experiences that encouraged them to become interested in science. For example, on the marsh field experience, learners were encouraged to jump and play in the mud as a means to demonstrate that learning science could be fun. The participants indicated that the activities helped them to see that science could be fun and prompted their interest to learn science. This focus on affective aspects of learning at the science camp positively influenced participants' identities as learners of science. The participants came to see science as fun and expressed an interest in engaging in science learning. They got opportunities to converse and talk with their friends which helped them to feel more comfortable in the science camp setting. By working in groups, participants felt that they were less under the watch of the teacher because accountability and expertise was distributed throughout the group. Another way that the science camp influenced confidence was through a re-conceptualization of success in science. Prior to the science camp, some of the learners framed their abilities in science within the world of school science. Thus, participants lacked confidence in their abilities because they saw success in science as performance on tests, memorizing facts and providing correct answers to teachers' questions. After engaging in the science camp program, participants redefined success in science which helped them to develop confidence in their abilities as a learner of science.

Wenger (2011) did a study on family learning experiences at an informal astronomy observing events in USA. This qualitative study was an exploratory look at family

experiences at night time telescope observing events, often called 'star parties'. Four families participated in this study which looked at their expectations, experiences and agendas as well as the roles that identity and family culture played in the negotiation of meaning. Two families who had prior experience with attending star parties were recruited ahead of time and two other families who were first time visitors were recruited on-site at the observing event. Data were collected at two star parties. At each event, one experienced family was paired with an on-site family for the purposes of facilitating conversations about expectations and prior experiences. The results of this study showed that learning constantly occurred among families. Expectations and agendas were found to affect the families' star party experiences and differences were observed between the expectations and experiences of families based on their prior experiences with star parties. The family members actively negotiated their individual and family identities. These families used their cultural history together to make sense of their star party experiences; however, the meaning that families negotiated was often focused more on developing family and individual identity rather than science content. The families in this study used the star party context as a way to connect with each other to make sense of their prior experiences and as raw material for making sense of future experiences.

Ball (2012) conducted the study to understand the experiences of a cohort of informal and formal science educators at Informal Science Institute (ISI) in USA. The study was done to know graduate students' perceptions while participating in the informal science institution graduate certificate program and to know the perceptions of the college professors and community representatives during the program. There were 11 participants in the study. The study concluded that the composition of the cohort and their collaborative activities established a vigorous community of practice which fostered community building, mentoring, and networking. The design and implementation of the long term program promoted experiential learning in a generative classroom. The members who were able to be independent or autonomous learners and who embraced science education reform strategies evidenced greater benefit. The ISI cohort consisted of a broad spectrum of people: experienced and novice professionals, formal and informal teachers and educators and scientists. All members had joined the program with a

common goal to update their science research knowledge, learn how people learn, learn ways to establish a network and develop means to effectively interface this network of informal science education providers with formal education institutions. The initiator/developers of the ISI certificate program were experienced professional formal and informal science educators, most of them stakeholders in the area ISI community.

Zandstra (2012) explored the impact informal science learning had on students' interest in science. The study focused on Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP) program in Texas (USA). The participants of this study were 122 eleventh grade students from this cohort. The findings of the quantitative phase revealed a correlation between students' attendance at the program elements (in total number of hours) and their science knowledge. In addition, small but significant correlations were found between students' attendance at the mathematics program element and their total interest scores, their mathematics attendance and the career interest sub-score and their total attendance and the normality of scientist subscore. The group participants agreed that they had learned from the GEAR UP field trips and half of them thought the field trips had impacted their grades and test scores. Furthermore, a majority of the focus group participants concurred that their experiences in the field trips had increased their interest in science. The field trips covered the same content as the formal science classes and that students learned more because they perceived the field trips as fun and hands-on. The correlations between attendance and interest were explained by the fact that students had the opportunity to see interesting aspects of science and interact with real scientists during the field trips. The focus group participants said they learned from their experience in the field trips because there were many opportunities to do hands-on activities and because they perceived the field trips as fun, which increased their ability to remember what they had learned. The trips provide students the opportunity to see more interesting aspects of science, to go more in-depth, and to meet scientists. Several students commented learning from field trips helped them in what they were learning in school. Half of the students thought their grades were impacted by the GEAR UP program elements while the other half did not think their

grades were impacted. For them, learning from the field trips actually translated into higher grades.

Birmingham (2013) had studied the impact of GET City program (Green Energy Technologies in the City) on girls. The study also examined view of teachers about the impact of this program on girls. There were four girls and three male teachers for the study. The results showed that the girls gain understanding of energy related science. The teachers noticed students' desire to be active participants in science investigations. The findings suggested that there was a need to provide spaces for students to leverage their strengths when learning and doing science and the importance of building connections between science and community.

2.1.4 Researches on Informal Education Programmes

The researcher came across 12 studies related to informal education programmes. Those are presented as follows.

Havasy (1997) carried out a research to know the effect of two informal science experiences on achievement and attitude toward science of secondary biology students in a typical New York State High School in USA. The participants in the study were two classroom science teachers and five 10^{th} grade biology classes. A science attitude test was used to compare the attitudes of students who had the informal science experiences to those who had not. The students who went to informal science institutions scored significantly higher on three subscales of the attitude test, indicating a more positive attitude toward science. In addition, scores on the New York State Regents Biology Exam were compared between the two groups of students. Once again, scores for students who went to informal science institutions were higher. Finally, fifteen students, selected at random, were interviewed to solicit their opinions about their general, as well as informal, science learning experiences. During the interviews the students indicated that informal science experiences were very relevant to learning.

Thomas (2000) carried out an investigative study to know third grade children's level of inquiry in an informal science setting. Observation of student behaviour and interview method was applied here. The observations were made while the 26 third grade students attended a field trip to the informal science setting. The informal setting comprised of interactive, open ended exhibits where the inquiry behaviour of the school aged children could be most naturally observed. This study revealed that when students were provided with the opportunity to become engage with and to explore exhibit materials in an open-ended context, they display similar patterns of behaviour. The inquiry behaviour ranged from simple observation of others using the materials to collaborative efforts to construct something from the available materials. During high levels of inquiry, use of inquiry-based materials was purposeful and inventive. The behaviour was task oriented and built upon previous ideas or constructions. The students engaged in medium level inquiry flipped through, stacked or arranged the available materials in a display without apparent regard for purpose. A low level of inquiry included behaviours which evidenced an apparent absence of task orientation. Collaboration was infrequent and usually not related to the exhibit or materials at low levels of inquiry. At low levels of inquiry, students tended to 'drive' by the exhibit, look at materials, observe others or read signage only. The findings of this study revealed that higher levels of inquiry were most often present when the inquiry-based materials available at the exhibits were engaging, familiar and which had some novel trait such as light, sound or movement. The types of prompts which most positively impacted the level of inquiry were prompts which encouraged the young student to investigate a new feature of the exhibit or which challenged to complete a task. The levels of inquiry were raised because the prompts focused the students' inquiry upon connecting their preconceived ideas and actions to a new feature or to a specific challenge using the exhibit materials.

McCreedy and Dale (2003) conducted the study to understand how National Science Partnership (NSP) for Girl Scouts and Science Museums, an informal community programme is benefitting adult females. The study aimed to know perception about informal and community based context that help them to appreciate science connections in their lives that are ultimately empowering. The participation in NSP offered benefits to

all three members, each in a different way. The informal community of practice was able to empower women in the practices of learning and teaching and stimulated them to thinking about science in new ways that were embedded in real lives. NSP created a place in which women's legitimate peripheral participation could happen and where participants could feel valued as they acquired legitimacy within the community and took an active role in its domain, community and practices. Science become agents of change as participants engaged in trajectories of participation that were validating and empowering. Their participation and insights and the ways in which the community was a part of the negotiation and development of these women had the potential to shape future efforts and strategies for promoting a more equitable and science literate society. The participation in NSP provided an informal, non-threatening place in which girls and adults could acquire the capacity and the identities necessary to become full participating members in science learning.

Robertson (2003) examined the nature and process of collaboration between formal education, informal education and educational research for the purpose of creating educational field trip experiences. The result showed that the students gained cognitively, affectively and socially from the educational experiences created through the collaboration. The findings suggested that the steps such as working towards communication and understanding others' perspectives should continue to be taken to ensure the collaboration continues beyond the term of the current key participants.

Randol and Meyer (2005) conducted a research to understand the nature of inquiry in free-choice settings and to design a means to assess the quality of inquiry achieved by visitors at exhibits. A conceptual framework was developed resulting in three characterizations of inquiry-1) Action Based-inquiry as a process involving the use of a collection of skills or actions, 2) holistic-based on descriptions of features of the process of inquiry as a whole and 3) definition based structure around how and why people do inquiry. The findings indicated that measures from the action-based assessment instrument correlated highly with scores from holistic and definition based instruments suggesting validity across instruments. The results showed that most visitor groups had a

purpose for using exhibit and know what to do to achieve that purpose. Most exhibit interactions that were observed showed visitors simply doing what the exhibit affords and watching to see what happens. The common patterns of inquiry were explored using a new technique of representing data called an Inquiry Trace, an ordered record of inquiry-related actions performed by participants.

James and Sylvia (2007) conducted a study to know impact of out-of-school-time (OST) science enrichment program to African Americans. The results showed that authentic science learning experiences, youth development, social interactions and relationship with staff members of science program were important factors in science enrichment. The informal learning settings were supportive environment for science learning.

Simpson (2007) carried out a qualitative study of an informal science enrichment program that was done with African American perspectives. The purpose of the study were to determine what program characteristics African American parents consider when they enroll their children of third to sixth grade into an informal science education enrichment program called Jordan Academy. The findings revealed that the participants believed that informal science education offered their children opportunities which were not possible in the formal school setting. The parents and students in Jordan Academy also shared their appreciation of having a cultural connection to the science they learned. The parents expressed the academic, cultural and personal development of their children in their characterizations of the ideal informal science education experience and in their evaluations of Jordan Academy.

Brackney (2008) did a study on influence of field study on learning and attitudes towards science. The location of the study was centred on an Earth Science course in a Christian College of liberal arts in the north central region of the United States. The purpose of the study was to explore the extent of geologic content learned in an informal educational experience versus a formal course of study over the same material The study was carried out to explore possible relationships between an informal educational experience and student attitudes towards science as well as to examine students' views, ideas and

attitudes towards participating in a field study experience and discover possible patterns in response regarding positive and negative aspect of the informal course. The participants of this study were students who were enrolled in a formal earth science course and those in an informal earth science field study. The total number of participants was 83. Interviews and observations were done for the study. The results indicate that students in the informal field study course gained more content knowledge compared to students in the formal on-campus course. The students had more gains in the two week (concentrated) field course than the longer (8 weeks to 16 weeks) formal course. This was because of direct experiences and discussion with peers that students were able to experience each day in the field course. The opportunities for students to develop ownership of their learning, exposure to experience directly the phenomenon under study, freedom to ask questions of the instructor at any time and when the questions come to mind in a low stress, high comfort level atmosphere and time to do dialogue with peers was facilitated and encouraged. The results from the attitude survey indicated that while the mean attitude score for field study participants was numerically higher than the mean score for enrolled in a formal course, it was not significantly so. Thus, the attitudes and interest toward science were not different between students given the informal and formal Earth Science experiences. Half of the participants revealed that they enjoyed the unconstrained setting, with 40% remarking positively that there was time and flexibility to explore their own interests.

Falk and Storksdieck (2010) investigated about role of informal activities in science learning. The four science centres of recollection-narratives helped to illustrate important things about adult free-choice learning and possibly learning in general. Whether, what and how someone described the science they learned as a consequence of visiting the science centre depended on the role an individual was playing, the traits an individual ascribed to themselves (e.g., curious, supportive), the individual's perceived abilities (e.g., good/knowledgeable about science or not) and their personal interests and needs. In short, as predicted, learning correlated with an individual's museum-going self-aspects at the time of their visit. The four featured vignettes were typical of the stories each of the 52 interviewees shared with us; stories that showed both how complex and personal each

individual's learning experiences was. These four vignettes also provided a glimpse into the diversity of visit benefits/learning outcomes that a science centre visit affords. The depth of science learning varied considerably across the four individuals; for some it was considerable and for others it was quite limited. In some cases it represented the addition of new science concepts but in most cases it represented an expansion and elaboration of existing understandings.

Goodman (2009) conducted a research to know effects of an informal energy exhibit on knowledge and attitudes of fourth and fifth grade students in Purdue (USA). This study examined impact of an informal energy education exhibit that would yield an increase in participant's knowledge of energy concepts as well as motivation for and attitudes towards renewable energy. Interview and observations were conducted during a time period when both fourth and fifth grade students visited the exhibit while on display at Purdue University campus, Christian School and Faith Community Centre. Cognitive and affective change of the fourth and fifth grade groups were compared within and across groups using a multiple choice and open-ended survey for knowledge change. Three point Likert scale survey was also used for attitude change assessments. The results showed that fourth and fifth grade students benefitted from interacting with the exhibit. The participants learned facts about energy and renewable energy as a result of interacting with the exhibit and showed positive attitudes toward the exhibit and the energy topics associated with the exhibit. Observations revealed how children interacted with an energy exhibit. The children tended to visit the exhibit multiple times with each visit resulting in deeper interaction with the exhibit. The students opined that they felt capable of tackling energy issues. The students had limited prior knowledge of energy topics, had positive attitude towards science, energy and the exhibit. 87% (46 of 53) participants stated that they enjoyed the exhibit. Overall 45% (24 of 53) participants believed science was important and should be understood by the general public, though the favorable responses dropped from 59% in fourth grade to 21% in fifth grade.

Roseler (2013) conducted the research to explore the relationship of informal experiences and the development of science identity as well as characterize these science learning

experiences. The sample was 196 science and non-science degree-seeking college students enrolled at an urban research intensive university located in the southeastern United States. Drawing results identified characteristics of out-of-school science experiences including those identified as biological (animals, plants, health), outdoor locations (beach, forest, ocean) and activities that were performed with or without others. The demonstrations of interest were identified through expressions that indicated curiosity. The participants indicated enactment of science identity on three levels: low, moderate and high. The participants who demonstrated higher levels of identity demonstrated greater science interest and consumption verses those demonstrating moderate and low levels of identity. The majority of the participants who demonstrated the highest levels of science identity had a mentor. The participants saw themselves as engaging in science primarily during "free-choice" science activities such as cooking and sports rather than through more formal, structured places and events (e.g., museums, aquaria). These "free-choice" activities were portrayed as personally relevant and suggested that participants identified themselves as being interested or proficient in these activities. The participants demonstrating moderate levels of science identity demonstrated high interest hobbies and the connected scientific information. These participants discussed their hobbies or science-adjacent activities (e.g., motorcycle maintenance, sound engineering, rock climbing, playing a musical instrument), associated scientific information and how that information was used to influence the way they engaged in their hobbies. The participants who had moderate level of identity demonstrated clear understanding of scientific principles and practices connected to their science-adjacent activities but did not demonstrate a desire to be seen as science savvy. The participants who demonstrated high levels of science identity did so through an overt need to be seen as science savvy. The research suggested that informal science education experiences impact, motivate and assist in developing interest in science, each of which contribute to the development of one's science identity.

Dawson (2014) explored the perception of people from low-income and minority ethnic groups about informal science education (ISE) institutions such as museums and science centres in London. The participants came from four community groups in central

London: a Sierra Leonean group of 21, a Latin American group of 18, a Somali group of six and an Asian group of 13 persons. The result showed that informal science institutions were helpful in understanding science concepts. The groups gained fruitful knowledge on science in museums and centres.

2.1.5 Researches on Activity Based Educational Programmes

The researcher came across seven reviews of literature on activity based educational programmes which are as follows.

McCarthy (2004) did the study comparison of student performance on the assessment modes between the students in the hands-on thematic science program and the textbook-oriented program. The research studied about effects that can be seen on each measure of science achievement for students in the hands-on thematic program and the textbook-oriented program. The students were from 12 different sub-urban school districts placed in a self-contained setting for students with emotional disturbance through an Intermediate Unit in South-Eastern Pennsylvania (USA). The hands-on assessment format consisted of two performance-based assessments. The results of the study indicated that students with serious emotional disabilities perform significantly better on two of the three assessment modes studied when instructed in a thematic based, hands-on approach to science. This finding suggested that when activity-based instruction was appropriately structured, students with disabilities mastered concepts in science that were usually taught in regular science classrooms. All students demonstrated improvement in the traditional (multiple-choice and short-answer) and non-traditional (hands-on) assessments. The students in the hands-on condition were more engaged verbally in discussion than the students in the textbook condition. In the textbook condition, students were passive learners. They received factual information from reading the textbook aloud or listening to text being read. Most of the discussion during the lessons was aimed to generate factual recall of information. The students in the hands-on condition reviewed science information verbally before each lesson and not only asked questions during experiments but also answered questions related to content.

Palmer and Joel (2007) conducted a study to examine the impact of planetarium on students for understanding the phases of moon and eclipses. Total 178 students belonging to African American, Hispanic and White participated in the study. The study showed that planetarium activities improved the understanding of phases of the moon and eclipses. The visual representations in the planetarium helped in understanding the astronomy concepts.

Kralina (2009) studied about extracurricular activities that enhance science education activities in Suzy Science and Whiz Kids Club in USA. Interview and survey method was applied for the research. Total 110 respondents who joined the club, 110 respondents for survey and 100 interviews were taken from two schools were taken as a sample. The finding proved that extra-curricular activities involve exploratory, hands-on and trans-active in nature. It encouraged peer interactions, promoted co-operation and encouragement, provided structure and challenge and drew in a diverse membership in grade level, race and gender. There was high emotional engagement of science extracurricular activities (ECA) participation. The overwhelming reason given for joining science activities was for fun even though one third of the respondents said they hated science. The students were looking for ways to learn science in a more informal, fun environment, to come face-to-face with science at their own level and in the process they improve their attitudes toward science. The second finding revealed that in order for learning to occur, students must actively engage behaviourally, cognitively and emotionally. For changes to occur in the social positioning set by peers, family and school toward new trajectories offering wider educational opportunities and career aspirations, students must be mindfully engaged. Valuable learning experiences and mastery of new skills consistently keep students in extra-curricular activities. It was also concluded that teacher-student interactions are important.

Holstermann et al. (2009) had investigated the influence of hands-on activities on students' interest in Germany. The research was done to know whether students with experience in specific hands-on activities show higher interest in these activities than students without experience. Furthermore, the relationship between the quality of the

hands-on experience and interest in the respective activity was examined. In total, 28 typical hands-on activities of biology education were considered. The activities were divided into the categories like experimentation, dissection, working with microscopes, and classification of organisms. A total of 141 students from the 11th grade completed questionnaires on interest in the hands-on activities, their experience with each activity and the quality of the respective experience. The findings indicated that the performance of various hands-on activities influenced students' interest differently. Mostly, there was positive effect of hands-on experience on interest while in one case practical work appeared to have influenced students' interest negatively. However, for most hands-on activities, no effect of experience on interest was found. The quality of hands-on experiences showed positive correlations with interest in the respective hands-on activities. Inexperienced students did not really know the activity and therefore only estimated how interesting this activity or topic was for them. On the other hand, experienced students made an informed judgment about their interests since they knew that both activities were alike. The findings from the correlation analysis between the quality of hands-on experience and interest showed that for each hands-on activity, students' level of interest was higher the more positively the hands-on activity had been perceived.

Roberson (2010) conducted the research to determine the impact of a mobile science laboratory that was used to promote interest in science in teachers and students. He studied teacher competence and confidence in teaching science that encouraged students to consider careers in science, technology, engineering, and math (STEM). The participants in this study were students in grades 4 to 6 who participated in the TekMobile program. TekMobile was a mobile lab which was designed to provide access to hands-on science lessons primarily for school students. The lab was intended to foster future scientists, technologists, engineers and mathematicians to address the need for skilled workers in these fields. The results of the study revealed that after experiencing the mobile lab, the teachers were confident to teach science. The students were enthusiasm for science subjects and knowledgeable about science careers.

Ford (2011) conducted the study to know the students' perception of light phenomena in an informal science setting and determined if they learned the scientific concepts of light that were presented to them by an interactive science exhibit. The participants in this study made scientific inquiry about light by using a powerful white light source, a prism, converging lenses, diverging lenses, concave and convex mirrors. The sample used in this study consisted of 40 participants. A sample of five participants was randomly selected to participate in the interview process. The research concluded that there was a significant difference in the impact of an interactive exhibit's use on students' learning about light wave phenomena. There existed a moderate correlation between the participants' gender and their preference of the choice. The participants were capable of perceiving, grasping and learning about the important concepts about phenomena of light through interactive science exhibit by applying a hands-on approach.

Amin (2011) conducted a study on development and implementation of an activity based science teaching programme for pre-service student teachers. The objective of the study were to develop the activity based science teaching programme for the student teachers, to implement the developed programme on student teachers and to study effectiveness of this programme in terms of the differences in student teachers with respect to content knowledge of science and technology, experimental ability and understanding about nature of science. For the study, a sample of 41 student teachers was taken as a sample. The study concluded that it is possible to provide learning experiences based on experiential and collaborative learning techniques. The student teachers developed clarity on science concepts after the implementation of the programme. They enhanced their experimental skills and understanding about the nature of science. The activities like demonstration of experiments at science clubs, scientific toys and educational films sensitized them on science subjects.

2.2.0 IMPLICATIONS OF THE REVIEW OF RELATED LITERATURE FOR THE PRESENT STUDY

The researcher reviewed a total of 56 studies in which four were Indian studies while the rest 52 were foreign studies. The reviewed studies were mainly on the sub themes like,

science centres, science museums, non-formal programmes and field/camp based experiences, informal education programmes, activity based educational programmes.

Duensing and Jeanne (1999), Medved and Oatley (2000), Sandifer (2003), Botelho and Morais (2005), Sommerkamp (2005), Tlili et al. (2006), Rennie and Wiliams (2006), Davidsson and Jakobsson (2007), French (2007), Mathew (2008), Makwana (2008), Davidsson (2009), Falk and Needham (2010), Daneshamooz et al. (2013), Meshoulam and Feinstein (2013), Morentin and Guisasola (2013), Lelliott (2014), Senturk and Ozdemir (2014), Weiland (2014) and Falk et al. (2014) carried out studies on science centres to know their impact on students and public. The activities and programmes of these institutions proved to be supportive in education. However, these studies only revealed findings about activities and did not reveal the problems faced by the centre in achieving their objectives.

Rix and McSorley (1999), Rivera and Dian (2002), Melber (2003), Suzuki (2005), Meisner et al. (2007), Stroud and Sewand (2008) as well as Tomoko and Masakata (2015) did studies on science museums. The studies concluded that science museums were important places for science popularization.

Studies conducted by Vasava (1998), Kuo and Pi-Chu (2005), Ricks (2006), Votaw (2008), Preusch (2009), Riedinger (2011), Wenger (2011), Ball (2012), Zandstra (2012) and Birmingham (2013) conducted studies on the impact of non-formal programmes and field/science camps on students. These non-formal programmes, field trips and camp tour were found effective in enhancing science knowledge of the students, teachers and public. However, the studies did not reflect the nitty-gritty of science camps and how these camps were different from the formal science education tour.

Havasy (1997), Thomas (2000), McCreedy (2003), Robertson (2003), Randol and Meyer (2005), James and Sylvia (2007), Simpson (2007), Brackney (2008), Tomasek and Morton (2006), Goodman (2009), Roseler (2013), Dawson (2014) did studies on effectiveness of informal programmes. The focus was on the role of informal educational

programmes in educating students and public. These studies concluded that the informal programmes were very successful in creating awareness about science.

The studies conducted by McCarthy (2004), Palmer and Joel (2007), Holstermann et al. (2009) , Kralina (2009), Roberson (2010), Ford (2011) and Amin (2011) focused on activities conducted by informal institutions and concluded that these institution were effective for better understanding of educational concepts to students and public in non-traditional way.

The researcher observed few research gaps while studying and analyzing the review of relate literature. The studies did not reveal to what extent the objectives of these informal and non-formal programmes were achieved and the problems faced by the learners during the process. The researcher was unable to find the studies done on Community Science Centres in Gujarat except a study conducted on the Community Science Centre at Vadodara. No in-depth study was found on the Community Science Centres of Gujarat focusing on the critical analysis of objectives of the centres, extent of the achievement of these objectives, different issues and problems of administration, infrastructure, financial management, human resources management and implementation of activities. From the studies abroad, no such studies were reported to reveal the holistic aspects of Community Science Centres. Hence, the investigator had made an attempt to undertaken the study to research on Community Science Centres operating in Gujarat starting from the objectives of these centres, their functioning, level of achieving objectives and the problems faced by them.