Universal Curriculum Design in Science

Are we meeting the 21st Century Requirements?

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Abstract

Curriculum design is a term used to describe the purposeful, deliberate and systematic organisation of curriculum (instructional blocks) within a class or course. The purpose of curriculum design is to meet the educational needs of the learners, thereby improving their learning. The present study focuses on the learning requirements of the twenty-first century and whether the present science curriculum is meeting that requirement. Science is a subject which is mandatory in all schools, whether special or mainstream. The study aims to collect the opinion from the service providers (teachers, teacher trainers, etc.) as well as the service receivers (i.e., students) who are part of framing curriculum, as well as receiving the curriculum respectively. A five point likert scale questionnaire was developed for assessing the opinion of the service providers regarding the present science curriculum whereas the service receivers were also assessed for their opinion about the current science curriculum and its implication on their future life. Qualitative analysis of the data revealed that the present curriculum needs to be attuned with new age information and should be process oriented. Moreover, the student data also was in accordance with the service providers which revealed that the curriculum has to be reviewed frequently for meeting the learning requirements of the twenty-first century learners.

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Introduction

Science is a concept that is simple in theory and challenging (in terms of implementation) in practical. As educators, we want all the children to learn regardless of levels, to attain critical skills needed to make decisions based on logic and to understand the processes that underlie the science they come across in the news and in daily life. Research in science education across levels identifies gaps in foundational understandings of science among students and the public. The misunderstandings and misconceptions are the very ammunition used to attack scientific knowledge and discovery in the public sphere. To correct these problems lies not with the public but faculties of science whose role is not only teaching the content but providing and motivating students to value scientific knowledge and skills. According to the NSES, scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs and economic productivity.

Curriculum Design and its Relevance in the 21st Century

Curriculum design is a tool for teachers to plan teaching-learning process. When the curriculum is designed, it is needed to identify what will be done, who will do it, and what schedule to follow. The ultimate goal of curriculum is to make the teaching-learning process easy and standardised. In 21st century, the curriculum should focus on the following components to meet the requirements of the students in the context of core academic subjects which being construction of knowledge, critical thinking, problem solving, innovative skills, media and communication, information and communication technology and real life experience. An amalgamation of these will enable the present generation students to construct knowledge in the subject and thereby provide real-life experience. The curriculum should strengthen the learner's ability to construct, think clearly and rationally about what to do and believe. The learner should be in a position to define a problem; determine the cause of the problem; identify, prioritise, and select alternatives for a solution and implement a solution to their life.

Challenges in the Present Curriculum and need for Universal Curriculum Design

Curriculum for the learners must meet their present requirement as well as prepare them for the future learning and challenges of the ever changing society. The present curriculum is outdated, lacks academic research, absence of school teachers involvement and it is a result of weak academic skills of the researchers. It also poses challenges to teachers in terms of assumptions, goals, subject demarcations, the

content, the approaches and the methods of assessment (Bennie, Newstead,1999). However, there are many more challenges facing the teachers as well as the receivers in taking full benefit of the curriculum — limited availability of the resources, lack of clarity pertaining to reforming the curriculum to meet the needs of the learners, outdated skills and knowledge and limited scope for upgrading the skills. A mismatch between the teacher's residual ideologies and innovation in curriculum needs to be addressed so as to meet the learning requirements of the 21st century learners.

With the National Education Policy, 2020 and its aim being Universalisation of Education till 2030 from preschool to secondary level, it becomes all the more essential to have a curriculum meeting the requirements of the learners which is inclusive of their ability, gender, socio-economic background, etc. The instructional framework should enable all learners to be successful. The solution lies in Universal Curriculum Design, which offers options that enable learners with varying needs and preferences to access and engage with learning materials. This concept could be used for any subject provided it focuses on three core principles namely— opportunity for multiple means of presentation, multiple means of action and expression and lastly, providing multiple means of engagement. This could be supported by a report of Izzo (2012), wherein he found that universal design offers a promising approach to meet the learning needs of all students. It challenges the educators to rethink the nature of their curriculum and empowers them with flexibility to serve a diverse population of learners. It is based on the belief that evey learners brain is different. The goal is for every students, whether they have skills which needs to be nurtured, special needs, typical or advanced or to learn in their own style. This design of learning should encourage those skills which would enable the learner to survive in the 21st century world, learning the problem solving skills, critical thinking analysing, interpreting, evaluating, summarising and synthesising information. These are the skills which will give students the opportunity to be successful (Drew, 2013). Hence, the study was undertaken to evaluate the present science curriculum as to whether it is meeting the requirements of the 21st century.

Need for the Study

As Sir Ken Robinson correctly puts, "The more complex the world becomes, the more creative we need to be to meet its challenges" and this is even more true in education and the work place in the current scenario. Society and its needs are ever changing and its people need to change and adapt as per the requirement. This is possible through education. The 20th century education highlighted and nurtured qualities like compliance and conformity over

creativity. However, the 21st century education is all about bringing skills the students need to succeed in this new world, which is being called as the four "Skill for Today" namely creativity, critical thinking, communication and collaboration. It also brings about the need for knowledge construction, development of cognitive skill, innovation skills, media communication, implementing ICT and providing real life experience.

Unfortunately, students are still a part of the standardised curriculum and being taught through conventional methods which is based on one-size-fits-all pace. The advent of the National Education Policy, 2020 highlighted the need for changing current curriculum by modifying and bringing about a change in terms of its core essentials, more holistic approach, provision for critical thinking, discovery-based, discussion-based and analysis based learning.

The purpose of the study is to identify whether the designed curriculum and requirements of 21st century is implemented and met properly at the school level especially in science subject, since the science subject should include more practical exposure and skill development among students. The need was thus fulfilled in collaboration of feedback from the students as well as teachers with different sets of statements in identifying whether the requirements are met properly.

Aim of the Study

The study was taken up with the main aim of assessing the opinion of the service providers (teacher trainers, science teachers and special educators) and the service receivers (students) as to whether the present science curriculum is attuned to the learning requirements of the 21st century.

Method

The present study adopted a survey research design in order to identify, evaluate and interpret whether the present science curriculum is attuned with the learning requirements of the 21st century.

Participants

Two groups of participants participated in the study. The details are provided below—

Service Providers

The first group of participants for the study was the service providers. These included teacher trainers teaching in regular B.Ed colleges (10 nos.) and involved in grooming and training the next generation of teachers. The participants also included science teachers (15 nos.) teaching at higher secondary level as well as special educators teaching science subjects to children with hearing impairment (10 nos). The special educators were included as they also taught children with hearing impairment using the same textbook as other teachers. Since Universal Curriculum design

is bringing about uniformity, accessibility, flexibility by removing barrier hence, it was felt essential to include them in the study. They were identified through purposive sampling reaching out to as many service providers as possible having more than 10 years of experience in the field of teaching, and hence a total of 35 number of service providers consented for their participation in the study. The table below gives the details of the service providers.

group of participants, i.e., the service receivers.

Research Tools

After review of relevant literature, the investigators decided to develop two sets of questionnaire or survey tools keeping in mind two groups of participants who participated in the study. The investigators had identified ten areas of curriculum which requires attention as per the universal curriculum design. The

Table 1
Details of Service Providers

Details of the teachers from different set-up		
Teacher Trainees teaching in regular B.Ed colleges	Science teachers teaching in higher secondary level	Special educators teaching science subjects
10	15	10

** Other details like experience, age could not be collected as the teachers didn't provide the same in the google form.

Service Receivers

The second group of participants was the service receivers, i.e., the students. Students studying at the higher secondary grades (Class XI) were the next set of participants who agreed to participate and give their opinion on the current science curriculum. Since they were the service receivers and the curriculum design of any subject has an impact on them as well as their career hence it was decided to include them in the study. A total of 60 students participated in the study. The table below shows the details of the second

opinion scale was provided to the service providers as they were directly concerned with implementing the curriculum. Statements were framed to record whether the selected areas of curriculum require modification. A five-point opinion scale of 'strongly agree' 'agree' 'undecided', 'disagree' and 'strongly disagree' was incorporated to record the intensity of the opinion. The questionnaire consisted of questions seeking opinion about the science curriculum in meeting the needs for the present age learner, the requirements of Universal Design for Learning was

Table 2
Details of Service Receivers

Details of the teachers from different set-up	
Grade	**Total No. of participants**
XI	60

also addressed with questions like providing real-learning experience in science as well as developing creativity and critical thinking among children with hearing impairment, it also highlighted the role of the teacher in the 21st century being that of a facilitator rather than an instructor. Opinion about the current science curriculum was also gathered for further analysis. The concerns of Universal Design for learning were also emphasised. Similarly, for the service receivers, another set of questionnaire was prepared which being five-point frequencies scale of 'always' 'often' 'sometimes' 'rarely' and 'never' was incorporated to record the intensity of occurrence. The questionnaire consisted of items which analysed the frequency of activities conducted in the science classroom, namely developing independent problem solving skills, ample opportunity for creative and critical thinking, curriculum being adaptable, analytical and resourceful for meeting the requirements of the global environment. Similarly, the opinion of the student participants were also collected on components like concretisation of abstract concept and its relevance, making connection between physics, chemistry and biology, provision of sufficient practical exposure for meeting the industry requirements. It also highlighted the strategies incorporated for teaching science. Hence, the overall purpose for including two groups of participants as well as making two sets of questionnaire was to get a 360° views and opinion about the science curriculum and its relevance in the 21st century.

For the purpose of validation, the first draft of the questionnaire was provided to six science teachers having more than 10 years of experience. Those items which received 80 per cent consent from the evaluators were retained. Evaluators' suggestions for improvement of the tools were also incorporated. The tools are appended for further reference.

Data Collection and Analysis

The questionnaire was distributed to the participants after explaining the purpose of this study and seeking oral consent from them. In the presence of the researcher they had to fill in their responses. The filled-in questionnaires was collected and the cumulative score for each participant was calculated.

Results and Discussion

The study was conducted with the purpose of discussing whether the present science curriculum is meeting the learners' requirement to face the challenges of the 21st century.

Service Providers Opinion about the Current Science Curriculum

The questionnaire for the service providers had ten questions. The domains fixed were science curriculum and present industry requirement, equipping the present generation with new age information

learning and working, developing creativity, scope for real life experiences, role of a teacher as a facilitator rather than an instructor, emphasise on process learning, meeting the career requirement, provision of strong fundamentals and creating holistic individuals. The data were qualitatively analysed by computing the percentage. The results given below are in the consolidated form which reflects the opinion of the respondents.

Figure 1 indicates that most of the teachers agree that change in curriculum is more required and it should be learner centered. From the above figure, it is clear that 23.6 per cent of the teachers strongly agree that the curriculum should meet the needs of the students and it should give real life experience. 54.4 per cent of the teachers agree that curriculum should provide new information, it should be concentrated more on the process not on factual knowledge, and they opined that fundamentals of science learning should be strengthened that stays for rest of the students' lives. 14.8 per cent of the teachers have not decided about the curriculum design, and it is identified that the requirements of science curriculum is not much aware for those participants. Less than 4 per cent of the participants have disagreed that it is not necessary to meet the requirements all the time. The special educators who participated also agreed with the above that the role of special education should also be incorporated in the science curriculum. The curriculum should be designed to meet the needs of children with disabilities especially in science subject, keeping in the requirement for Universal Curriculum Design.

The study also has a descriptive result based on the requirements of science curriculum. Above 80 per cent of the teachers suggested

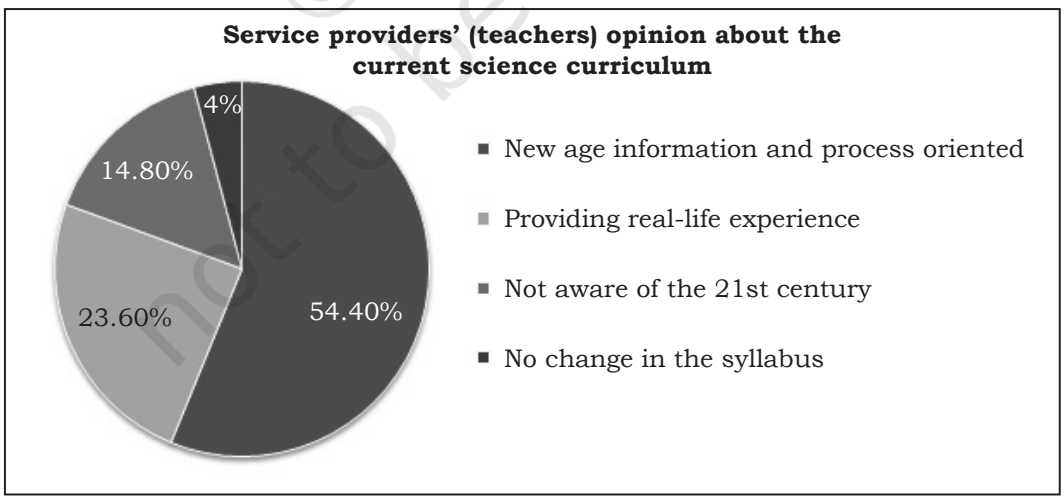

Figure 1: Service providers' opinion about the current science curriculum

that the curriculum should develop critical thinking, creativity, communication and collaborative learning process among students, and it should be the forefront in 21st century science curriculum. It is also suggested that practical exposure should comparatively be more than the theoretical exposure.

Figure 2 highlights the opinion of students who participated in the study. Their opinion was collected in terms of provision of opportunities in implementing the curriculum components like opportunities for creative and critical thinking, curriculum in terms of adaptable, analytical and resourcefulness, concretisation of abstract concepts, real-life connection with school subjects, provision of technical and practical exposure, provision of opportunities to develop a deeper understanding of scientific concepts, engagement in research and practical exercises and opportunities to solve a diverse set of problems and communicating the results. 50.4 per cent of the students responded that there is a need to review the curriculum in terms of teaching strategies, connectivity with real-life problems and more opportunities for creative and critical thinking frequently. In terms of the curriculum design 30.4 per cent of the respondents stated that redesigning of curriculum should be carried out often keeping in mind the ever changing requirement of the society. 15.2 per cent of the students responded that an opportunity to apply their learning in real-life situation is met sometimes. However, 1.7 per cent of the students stated that they never or rarely get an opportunity to solve a diverse set of problems and to communicate the results accordingly. It implies that the requirements in curriculum design are more important for the

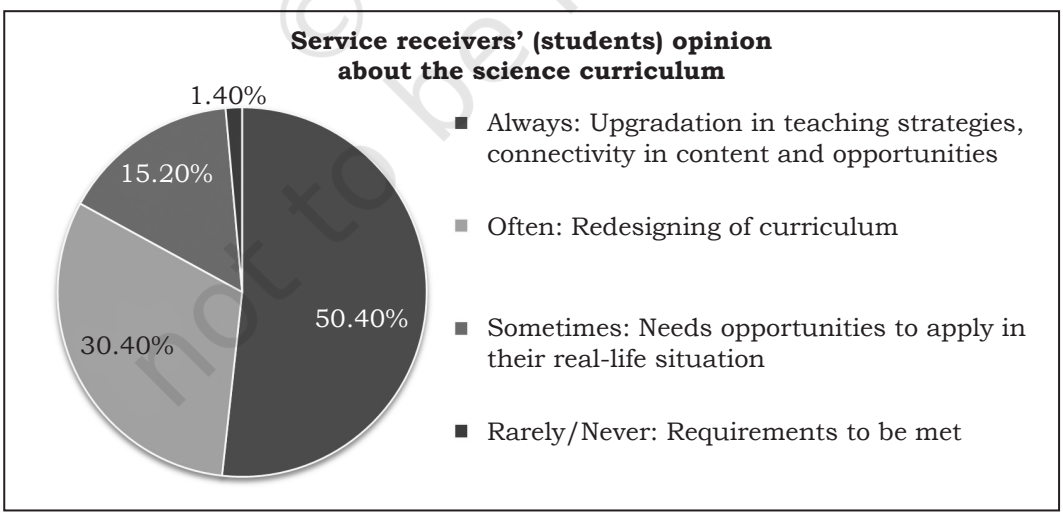

Figure 2: Service receivers' opinion about the science curriculum

students and it should be met at the maximum.

The teachers handling students with disabilities are also included and most of the teachers agreed that role of special education should also be incorporated in the science curriculum. The curriculum should be designed to meet the needs of children with disabilities especially in science subject which was a more important suggestion by the special educators as science is a subject which has implications in all walks of life whether personal or professional.

The study also has a descriptive result based on the requirements of science curriculum. Above 80 per cent of the teachers suggested that the curriculum should develop critical thinking, creativity, communication and collaborative-learning process among the students and it should be the forefront in the 21st century science curriculum. It is also suggested that practical exposure should comparatively be more than the theoretical exposure.

Implementing universal curriculum design, though unique and thoughtful for successful inclusion, faces a lot of hurdles and challenges which has been discussed above based on the results obtained. The challenges that the service providers as well as the service receivers are facing could be in line with a study by Scott (2018) which highlighted the barriers for implementing the UDL framework which states that for UDL to successful, it is essential to have an effective team, appropriate attitude along with appropriate administrative support, proper orientation and preservcie training, together all of which contributes to the success of UDL. Moresover for any science curriculum to be successfully implemented as per the requirement of the UDL it needs to be based on the three main principals of UDL which (1) providing multiple means of presentation, (2) providing multiple means of action and expression and (3) providing multiple means of engagement.

Conclusion

To conclude, it can be said that meeting requirements in curriculum is more important for students. Curriculum design and teachers' role in implementing the designed curriculum is more and requires meeting the needs of the students. Science curriculum is a common subject which has a general fact and concept all over the country, the requirements should be equally met to all the students. Providing adequate knowledge and practical exposure will help students to learn well and help them to implement it in their real life. If the need of typically developing children in science curriculum is not met, it is questionable to meet the requirements of children with disabilities in twenty-first century. The policy makers and the government should work for meeting the requirements in science curriculum for all children including children with disabilities.

Tool Developed for Service Receivers

Statement	
Your science teachers teaches in a such a way that you can independently discuss problems, critique theories and negotiate solutions with one another.	Sufficient technical knowledge and practical exposure is given in the Science class so as to meet the needs of the digital age.
Science teachers provides ample opportunities for students to think creatively and critically.	The present science curriculum which you are learning provides opportunities to develop a deeper understanding of scientific concepts.
Science curriculum encourages students to be adaptable, analytical and resourceful in order to succeed in a global environment.	The present science curriculum which you are learning reflects science in the real world.
Science teachers put an effort to make abstract concept into concrete and relevant to real life.	To encourage science learning, the school provides opportunities for students to interact with community scholars and engage in research and practical exercises.
Teacher emphasises the connection between physics, chemistry and biology so as to make it meaningful.	You as a science student had ample opportunities to solve a diverse set of problems and to communicate the results.

Tool Developed for Service Providers

Statement	
Our science curriculum, prepare all students for the new automation (mechanical) industry.	Present science curriculum emphasize more on the process and not on factual knowledge
The Science curriculum equips our present generation students for the new information-age learning and working.	Science curriculum is planned in such a way that it prepares the students with typically developing and hearing impairment to meet their career needs.
The science curriculum which is followed in school develops creativity in students with typically developing and hearing impairment.	Science education at all levels of schooling is often seen as abstract and irrelevant to real life.
The present science curriculum helps students with typically developing and hearing impairment to reflect real experiences.	As a teacher do you agree that it is important to give our student the fundamentals that will stay with them for the rest of their lives?
In the present science curriculum, the role of teachers is more of a facilitator rather than an instructor.	The present generation science curriculum prepares students as holistic individuals who can think analytically.

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