

## Effectiveness of Curriculum-Based Industrial Training for Undergraduate Professional Courses

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### Abstract

Education is one of the important needs of human life, like food, clothes, and housing. It helps to develop and nourish overall human personality and socialization through physical and mental abilities. Similarly, undergraduate courses are crucial in building personnel and professional careers worldwide. Undergraduate courses such as B. Pharm. and B. Tech. (Biotechnology) are demanding in the present situation and are conducted by various government and private universities. According to the course curriculum of the universities, curriculum-based industrial training for undergraduate students is part of their courses. Therefore, the present study was designed and conducted based on the one-month industrial training program for undergraduate students by the training department of Bharat Immunologicals & Biologicals Corporation Limited (BIBCOL), Bulandshahr, Uttar Pradesh, India as biopharmaceutical industry and also investigated the effectiveness of the training program for students as participants belonging to the undergraduate courses from different academic institutions. Results of the study revealed a significant impact of the designed and conducted training program on the participants through employing up-gradation in grade systems A, B, C, and D after the successful completion in BIBCOL as a biopharmaceutical industry.

**Keywords:** undergraduate courses, B. Pharm., B. Tech. (Biotechnology), curriculum-based industrial training, designed, conducted, effective, up-gradation system

### Introduction

Education is a right for every human, as per the Indian constitution, and it has a major role in building a good society with knowledge, skills, and mental ability. Education is a way to teach and train people at home, school, college, and university levels and helps you develop critical skills like decision-making, problem-solving, and logical thinking. Therefore, People use education to explore different world possibilities (Champathes, 2006).

Training and education are necessary tools for national development and individual development. Curriculum-based industrial training during undergraduate courses like B. Tech. and B. Pharm. is an important part of the courses to award the degree (Shah, 2016). This is only for industrial exposure to the student and may be helpful for their scientific future. Similarly, Coaching for performance improvement is used to nourish the skills of students and organization employees (Champathes, 2006). Designing, conducting, and implementing an effective training program is a practice in the way of systematic and strategic (Blanchard & Thacker, 1998; Milhem et al., 2014; Kumar, 2021a), and various researchers used training manuals for selecting criteria for participants and trainers for training purposes as per suggested by Imanyi, (2002). Based on the available literature, many kinds of evaluation methods and procedures by different

investigators to determine the effectiveness of training modules and programs (AL-Ajlouni et al., 2010; Iyer et al., 2009; Kumar et al., 2017; Kumar, 2019; Ramachandaran, 2010; Sim 1993; Srivastava et al., 2001).

In the current scenario, biotechnology and pharmaceutical are the most demanding branches of biology, and it is initiated at undergraduate courses such as B. Tech. and B. Pharm. Those branches cover required technologies for the production, quality testing, and registration of biological drugs and vaccines. In India, various central and state governments and private universities run undergraduate courses to educate in biotechnology and pharmaceuticals with approved curricula. According to the approved curriculum, there is a provision of one-month industrial training for industrial exposure, including overall knowledge of regulatory bodies for registration, G.M.P., G.L.P., production, and testing of biological drugs and vaccines (Moorthy, 2007).

Bharat Immunologicals & Biologicals Corporation Limited (BIBCOL) is a biopharmaceutical industry in Bulandshahr City of Uttar Pradesh, India. It facilitates training in biotechnology and pharmaceutical undergraduate and postgraduate students for curriculum-based industrial training. The author has already designed, conducted, and implemented various training programs with effective tools to assess employee performance improvement in his organization (Kumar et al., 2017, 2019, 2019,

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2021). BIBCOL exclusively designed the one-month training program for undergraduate students, especially for the biotechnology and pharmaceutical branches (Kumar, 2021b). Recently, one-month industrial training for B. Tech. and B. Pharm. students from undergraduate courses was conducted and completed in February 2023, and the data of all activities was documented, compiled, and analyzed to investigate the effectiveness of the curriculum-based industrial training for undergraduate level courses such as B. Pharm. and B. Tech. (Biotechnology). The grading system was used to analyze the data of pre-and post-training assessments and also applied up-gradation with A, B, C, and D grades of each participant to determine the effectiveness of the training program individually.

### Objectives

The present study was designed and performed with the following aims and objectives:

1. To design a one-month industrial training program exclusive for undergraduate level courses i.e., B. Pharm. and B. Tech. (Biotechnology) as per the training cycle.
2. To conduct the training program from 01st to 28<sup>th</sup> February 2023.
3. To investigate the effectiveness of the training program for each participant.

### Methodology

#### Design

Bharat Immunologicals & Biologicals Corporation Limited (BIBCOL) is a well-known biopharmaceutical industry. It produces and tests the viral vaccine and other biopharmaceutical products in Bulandshahr City of Uttar Pradesh, India. It facilitates training the biotechnology and pharmaceutical undergraduate students for their curriculum based industrial training through design and conduct the exclusive training program as previously described by Kumar (2021b). The one-month training program was exclusively designed for undergraduate courses like B. Pharm. and B. Tech. (Biotechnology) and covered topics and activities that filled the knowledge gap between academic and industrial, as summarized in Table 3.

#### Participants

A total of 45 participants participated in the curriculum-based one-month industrial training and these were studied in four

**Table 3**  
Detail of One Month Training Program

Department	Weekly schedule	The topic and activities covered
Training	Pre-training assessment day	<ul style="list-style-type: none"> <li>Assurance of the standard registration process of the participants</li> <li>Understanding the Biotechnology industries</li> <li>Training schedule and activities</li> <li>Pre-training assessment</li> </ul>
Quality assurance	1st week	<ul style="list-style-type: none"> <li>Schedule M for G.M.P., manufacturing processing, quality testing of product and infrastructure</li> <li>Organization structure and human resources</li> <li>Role of G.M.P. in vaccine manufacturing, testing, and good document practices</li> <li>Biotechnology Industries: Premises, equipment's, sanitization, and hygiene</li> <li>Clean room concept in Biotechnology Industries</li> <li>Qualification of facility</li> <li>Validation of equipment's</li> <li>Regulatory affairs related to granting the licence and its renewal</li> </ul>
Manufacturing	2nd week	<ul style="list-style-type: none"> <li>Schedule M for G.M.P. related to manufacturing</li> <li>Process activity in manufacturing, like sampling points during vaccine production</li> <li>A brief account of vaccine activities, including washing, sterilization, blending, filling, packaging, and storage</li> <li>Good document practices during vaccine production and storage</li> <li>Clean room concept in vaccine Industries</li> <li>Area grading of manufacturing</li> </ul>

years of professional-level courses like B. Pharm. and B. Tech. (Biotechnology) with 100% attendance and participation in pre-and post-training assessments as eligibility criteria. All the participants were enrolled through standard procedure only after filling out the request form, followed by an interview for registration in the training program. Details of course-wise participants were described in Table 1 and gender-based data in number and percentage of participants was also provided in Table 2.

**Table 1**  
Detail of Course-Wise Participants in the Industrial Training Program

Discipline	Participants	
	n	%
B. Pharm.	25	55.56
B. Tech. (Biotechnology)	20	44.44
Total	45	100

**Table 2**  
Data of Training Participants In Numbers and Percentage in Discipline-Wise and Gender Based During the Training Period

Discipline	Participants					
	Male		Female		Total	
	n	%	n	%	n	%
B. Pharm.	21	46.67	4	8.89	25	55.56
B. Tech. (Biotechnology)	15	33.33	5	11.11	20	44.44
Total	36	80	9	20	45	100

#### Training Program

The one-month industrial training program was exclusively designed for B. Pharm. and B. Tech. (Biotechnology) students and conducted in February 2023 (Kumar, 2021b). The training division informed all participants about the training program and schedule. The details of the one-month training program are summarized in Table 3.

Department	Weekly schedule	The topic and activities covered
Quality control	3rd week	<ul style="list-style-type: none"> <li>• Ascetic processing and handling for vaccine production</li> <li>• Cold chain management for vaccine storage and transportation</li> <li>• Schedule M for G.M.P. &amp; G.L.P. related to the quality control</li> <li>• Laboratory quality and management system for quality control and its testing</li> <li>• Quality testing of raw materials, water for Injection, finish products etc., as per the current Pharmacopeia commission</li> <li>• Washing and sterilization of glassware and other required materials</li> <li>• Preparation and sterilization of growth media and other medium</li> <li>• Raw and packing material testing and analysis</li> </ul>
Utility	4th week	<ul style="list-style-type: none"> <li>• A brief account of G.M.P. and utility services in Biotechnology Industries</li> <li>• Uninterrupted electricity supply</li> <li>• Water quality system for vaccine production and testing</li> <li>• Steam generation system and maintenance</li> <li>• Compressed air generation, supply, and maintenance</li> <li>• Heating Ventilating Air conditioning system(HVAC)</li> <li>• Maintenance of clean rooms A, B, C, and D grade in vaccine Industries</li> </ul>
Training	Post-training assessment day	<ul style="list-style-type: none"> <li>• Post-training assessment</li> <li>• Distribution of certificate</li> <li>• Evaluation and effectiveness of the training</li> </ul>

### Training Procedure

The training was designed and conducted with minor modifications in the Training cycle as previously described by Kumar et al. 2017 and Kumar, 2022.

### The procedure of Conducted Training

The training was developed only for four-year professional B. Pharm. and B. Tech participants. (Biotechnology) courses. It was a curriculum-based one-month Industrial training and divided into three major parts.

Part 1 was pre-training assessment day and included activities such as understanding the Biotechnology Industries, Training schedule and activities, and Pre-training assessment. The Training Department carried out these activities.

Part 2: It was the core part of the training, which was divided into four weeks: one week for each department like Quality Assurance, Manufacturing, Quality Control, and Utility. The details of the covered activities and topics are already described in Table 3.

Part 3: It was post-training assessment day and included activities such as Post-training assessment, Distribution of Certificates, and Evaluation and effectiveness of the training. The Training Department carried out these activities.

### Questionnaire Format for Pre- and Post-Training Assessments of the Participants

The format of the questionnaires was designed for pre- and post-assessments of participants for the training. The questionnaires were divided into three major parts:

Part 1: The first part provided detailed information about individual employees such as name, designation, employee code, department with section, signature with date, training objective, duration, and venue.

Part 2: The second part provided details of the training division, such as marks (Total and obtained), names with signatures of evaluators (preparation of questions and the answer keys), and cross-checked by the senior officer.

Part 3: The third part provided detailed instructions to the participants for pre- and post-assessments of the sessions and ten multiple-choice questions.

### Effectiveness for Participant of the Training

The effectiveness of the training was done through pre- and post-training assessments of the participants, followed by the up-gradation analysis of each participant after the completion of the training program (Kumar et al., 2017). Documentation of the training program was done and maintained for individual

participants to ensure the effectiveness in the approved formats as given below:

1. Development of the approved formats of the exclusive training program
2. Selection of participants through the standard registration process
3. Monthly attendance records of all participants
4. Records of pre-and post-training assessments
5. Department-wise weekly record to cover the topics and activities
6. Coordinate the pre-decided schedule of the training program

### Pre- and Post-training Assessment with Grading System

The pre-training assessment of all participants was performed before the start of the core training part, and the post-training assessment of all participants was performed after the completion of the core training part. The assessment was acquainted with ten multiple-choice questions, each question carrying one mark. Participants who secured a minimum of 50% marks in the pre- and post-training assessment. A grading system with minor modifications was adopted to assess the training participant's performance, as previously described by Kumar et al. 2017 and also given in Table 4. Each participant was placed in the grade based on obtained marks and percentage in pre-and post-training assessments. The data was prepared and compiled in table form with the help of the computer.

**Table 4**

Grading System for Assessment of Training Participant

Grade	Percentage range
A	90 % to 100 %
B	70 % to 89 %
C	51 % to 69 %
D	50 %

### Up-Gradation of Participant

The effectiveness of the training was determined after applying the up-gradation of participants in the grading system based on the participant's performance after completing the one-month training. Each participant was evaluated to measure the training effectiveness with the help of up-gradation of participants through one to another grade, and a list of the possible up-gradations is given in Table 5.

**Table 5**  
Possible Up-gradation of the Participant

S. no.	Possible up-gradation
1	B to A
2	C to A
3	D to A
4	A to A
5	C to B
6	D to B
7	B to B
8	D to C
9	C to C
10	D to D

**Training Data Analysis After Up-Gradation**

Data from the post-training assessment was rearranged to incorporate the up-gradation of each participant for further analysis. The data analysis was used to individually determine the training effectiveness for participants. The data was prepared in tabular form with the help of the computer. Each participant was placed in the up-gradated grade based on obtained marks and percentage in the post-training assessment, as shown in Table 5.

**Results and Discussion**

Nowadays, various four-year courses are running after obtaining approval from the concerned government bodies by the different colleges, institutions, and universities. Of these courses, B. Tech. in Biotechnology and B. Pharm. are the most popular and most demanding courses in research development and industrial production of biopharmaceutical products such as drugs, diagnostics, and vaccines in post-COVID-19 scenarios. In India, various government and private universities are running these undergraduate courses to educate and update budding biotechnologists and pharmacologists through new and novel technologies to develop new and novel therapeutic, diagnostic tools, and vaccine candidature. These universities have a uniform and approved curriculum for the course content taught by qualified academicians. As per the approved curriculum, one month of industrial training is mandatory for every student of these four-year courses. The training duration provides industrial

exposure, including overall knowledge of regulatory bodies for registration to grant the license, process flow of production, and quality control testing of biological drugs and vaccines.

The details and procedure of the training program are already described in the methodology section of the manuscript, and the training was exclusively designed and performed based on a training cycle (Kumar et al., 2007; Kumar, 2022). After completion of the selection procedure, a total of 45nos. including 20nos. (44.44%) from B. Pharm. & 25nos. (55.56%) from B. Tech. (Biotechnology) of participants participated in the present study. Details of the participants in numbers and percentage discipline-wise and gender-based have already been given in Table 2. All technical and scientific departments played their role in completing the one-month training program, viz. Training, Quality Assurance, Manufacturing, Quality Control, and Utility department. The department-wise weekly schedule was prepared with topics and activities described in Table 3. Each department delivered lectures, demonstrations, videos, facility visits, assessments, Question & Answer sessions etc. The grading system was used to find out the effectiveness of the training through pre- and post-training assessment of each participant, as given in Table 4. Possible up-gradation in the grading system was employed for evaluating each participant's performance in pre- and post-assessment during the training, as given in Table 5.

Different researchers worked on the development of new designing, conducting, and implementing of effective training programs (Blanchard & Thacker, 1998; Milhem et al., 2014; Kumar, 2021a) and used training manuals for selecting criteria of participants and trainers for particular training purpose (Imanyi, 2002). Different evaluation procedures and methods were employed to determine the effectiveness of training modules and programs (AL-Ajlouni et al., 2010; Iyer et al., 2009; Kumar et al., 2017; Kumar, 2019; Ramachandaran, 2010; Sim, 1993; Srivastava et al., 2001). In the current study, data of pre-and post-training assessments of each participant was compiled to find out the effectiveness of the conducted training and each participant was placed based on obtained percentage in the grading system, such as grade A for percentage range from 90 % to 100 %, grade B for percentage range from 70 % to 89 %, grade C for percentage range from 51 % to 69 %, and grade D for percentage 50 %. Overall, data from the training was expressed with the grading system (Table 6).

**Table 6**  
Pre- and Post-training Assessments of the Participants

Discipline of participant	Grade	Assessment of participants			
		Male in number (%)		Female in number (%)	
		Pre-training	Post-training	Pre-training	Post-training
B. Pharm	A	00 (.00%)	14 (66.67%)	00 (.00%)	3 (75.00%)
	B	4 (19.05%)	6 (28.57%)	1 (25.00%)	1 (25.00%)
	C	16 (76.19%)	1(04.76%)	3 (75.00%)	00 (.00%)
	D	1(4.76%)	00 (.00%)	00 (.00%)	00 (.00%)
Total		21 (100%)	21 (100%)	4 (100%)	4 (100%)
B. Tech. (Biotechnology)	A	00 (.00%)	13 (86.67%)	00 (.00%)	4 (80.00%)
	B	5 (33.33%)	2 (13.33%)	4 (80.00%)	1 (20.00%)
	C	9 (60.00%)	00 (.00%)	1 (20.00%)	00 (.00%)
	D	1 (06.67%)	00 (.00%)	00 (.00%)	00 (.00%)
Total		15 (100%)	15 (100%)	5 (100%)	5 (100%)
Grand total		36 (80%)	36 (80%)	9 (20%)	9 (20%)

The result from Table 6 shows that the assessment of all the participants was performed on the basis of their performance in the pre-training assessment on the first day and post-training assessment on the last day of the conducted training and the participants were placed in the grade A, B, C, and D as per obtained marks or percentage. In the case of B. Pharm., male participants were listed in grades D, C, B, and A; 1, 16, 4, and 00 numbers in the pre-training assessment and 00, 1, 6, & 14 numbers in post-training assessment as well as female

participants were listed in grade D, C, B and A; 00, 3, 1, & 00 numbers in pre-training assessment and 00, 00, 1, & 3 numbers in post-training assessment, respectively. In the case of B. Tech. (Biotechnology), male participants were listed in grades D, C, B and A; 1, 9, 5, & 00 numbers in pre-training assessment and 00, 00, 2, & 13 numbers in post-training assessment as well as female participants were listed in grade D, C, B and A; 00, 3, 1, & 00 numbers in pre-training assessment and 00, 00, 1, & 3 numbers in post-training assessment as well as female participants were

listed in grade D, C, B and A; 00, 1, 4, & 00 numbers in pre-training assessment and 00, 00, 1, & 4 numbers in post-training assessment, respectively. The training data was analyzed after a post-training assessment of participants that no participant from B. Pharm. and B. Tech. (Biotechnology) was placed in grades C & D except 01 no. (4.76%) male of B. Pharm. discipline. In B. Pharm. discipline, the number of male participants was increased in grade A; 14 nos. (66.67%) instead of 00 no. and the number of female participants was also increased in grade A; 3 nos. (75.00%) instead of 00 number. In B. Tech. (Biotechnology) discipline, number of male participants increased in grade A, 13 nos. (86.67%) instead of 00 no. and number of female participants also increased in grade A; 4 nos. (80.00%) participants instead of zero number. In spite of this, male and female participants from both disciplines decreased up to 00 numbers in grade C of post-training assessment except only 01 no. (4.76%) male decreased from 16 (76.19%) in B. Pharm. discipline.

In the present study, all participants were evaluated after completion of the training to measure training effectiveness by using inter-upgradation of the participant from one to another grade after post-training assessment and the results were summarized in Table 7.

**Table 7**  
*Effectiveness of the Conducted Training for Participants Through Inter-Up-Gradation in the Grade System*

Discipline of participant	Upgradation in grade	Post-training assessment of participants			
		Male		Female	
		n	%	n	%
B. Pharm	B to A	4	19.05	1	25
	C to A	10	47.62	2	50
	C to B	6	28.57	1	25
	D to C	1	4.76	0	0
Total		21	100	4	100
B. Tech. (Biotechnology)	B to A	4	26.66	3	60
	B to B	1	6.67	1	20
	C to A	9	60.00	0	0
	C to B	0	00	1	20
D to B	1	6.67	0	0	
Total		15	100	5	100

The result from Table 7 shows that the effectiveness of the training was determined after applying inter-upgradation of participants in the grading system based on participant's performance in post-training assessment after completion of the one-month training. All male and female participants from both disciplines were found to upgrade except B to B up-gradation in B. Tech. (Biotechnology) discipline, where only one no. (6.67%) male and 1 (20%) female. Out of 45 participants, only 36 males and nine females participated in this program, and it had a remarkable and significant impact on the overall knowledge of all the participants after the successful completion. Finally, the participants were placed in grade A [27nos] from both disciplines. (75%) male & 6nos. (66.67%) female], grade B [8nos. (22.23%) male & 3nos. (33.33%) female] and grade C [1no. (2.7%) male & nil female].

Kumar et al. (2017) employed the grading system to determine the effectiveness of training technical employees in the biotech industry. In this study, the evaluation and effectiveness of In-house training was determined and assessed for employee performance through questionnaires in pre- and post-assessment, and grading system such as grade A, B, and C was used to measure the training effectiveness after completion of all six trainings. The study revealed that the training programs were found more effective in grade A for employee percentage in production (18.36%) compared to quality control (12.26%) department. It was found effective for technical

employees by adopting a grading system in terms of their skill improvement, learning attitude, interaction with other departmental employees, and healthy discussion within the organization (Kumar et al., 2017, 2019, 2019, 2021a).

Out of 45 numbers participants, 44 numbers (97.78%) were placed to score range of percentages after the successful completion and result analysis of the training program in grade A (35nos.) with 90 % to 100 % and grade B (9nos.) with 70 % to 89 % as indicated in the above Table 4. It means the training program greatly impacts all the participants and enhances their overall theoretical and practical knowledge. Based on the results analysis of this study, the author concludes that the outcome is remarkable and a significant impact of the curriculum-based one-month industrial training program on the participants' overall knowledge.

## Conclusion

The current study was exclusively designed and conducted for students as participants of undergraduate courses like B. Pharm. & B. Tech. (Biotechnology) from different Indian government and private universities and colleges. The training is part of their curriculum-based industrial exposure for the students and investigated for the effectiveness of the training program for each participant who has undergone the training. This is the first study from our organization. After adopting the grading system and up-gradation system, it was effective for all participants to improve technical and scientific skills through lectures, demonstrations, interaction, and healthy discussion with the field experts from different departments. Results of the study revealed that the training program has a remarkably significant impact on the participants' overall knowledge after the successful completion in term numbers of placed participants in grade A from both disciplines; 27nos. (75%) male & 06nos. (66.67%) female. Based on the study, the author suggested that every training program should be investigated for its effectiveness towards each participant for further improvement in the course delivery.

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