Journal of Engineering Education Transformations ,
Volume 37 , No. 3 , January 2024 , ISSN 2349-2473, eISSN 2394-1707

10.16920/jeet/2024/v37i4/24158

Making Industrial Visits More Outcome Oriented

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Abstract: Industrial site visits play a crucial role in addressing the graduate outcomes of engineering education. However, it is a common observation that such visits result in less learning and more fun. This paper attempts to quantify the outcomes of industrial visits using a proposed pedagogical method named Stimulate – Experience - Assimilate/Accommodate - Reinforce (SEAR). The method has been developed using the social constructivism principle. This paper demonstrates the efficacy of this method through a case study of two industrial visits for Chemical Engineering third-year undergraduate students. The first visit lacks any unique input, while the second visit follows the SEAR method. This includes modified classroom inputs, pre-visit questionnaires for stimulation of interest, on-field experience during the visit, post visit questionnaires for assimilation of the gained knowledge and reinforcement through report compilation and presentations. The outcome attainment for the first visit is 52.95% while that for second visit is 77.78%. The results of the outcome assessment are statistically examined and the SEAR method is found to be effective in achieving the outcomes of the industrial visit. The proposed SEAR method is a combination of classroom, inquiry based, experiential and collaborative learning. It will help academicians to design more engaging and outcome oriented industrial visits. This will further help pave the way for creation of graduates with greater employability skills.

Keywords: Industrial Visits; Engineering Education; Outcome Assessment; Employability

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1. Introduction

Engineering education is incomplete without the exposure to practical knowledge. Industrial visits form one such activity in the curriculum where the students can explore the industrial environment and relate their theoretical knowledge with the real-world scenarios. The National Educational Policy of India (NEP, 2020) recommends compulsory exposure to industrial training.

Industrial visits have been known to offer several benefits. They are a valuable form of student engagement(Creasey, 2013). They provide experiential learning and complement classroom learning(Sawhney & Mund, 1998). Students can practically see the theory in action and thus connect the curriculum to their profession.(Papadopoulos et al., 2011).

Pratibha et al. have discussed the importance of industry interaction in developing the foundation for the fundamentals of the students. (Pratibha et al., 2021). Industrial visits can lead to Industry-Academia collaboration and generate more research opportunities and knowledge transfer (Oliver, 2004). Fadhli et al have shown the enhancement of the soft skills of the students through the industrial visits (Fadhli et al., 2017). They help students to visualize the work profiles of the employees and their day-to-day roles in the industry (Carbone et al., 2020). Students can clarify their misconceptions about engineering practice when they are exposed to real world engineering scenarios (Male & King, 2014). Similar benefit in changing the perception of students towards Chemical Engineering profession through industrial visits has been reported by Wolff, Dorfling and Aldogan (Wolff et al., 2018).

Industrial visits have added advantages of exposing students to industry management relevant terms like Green Manufacturing Practices, Lean Manufacturing Practices and Value Stream Mapping. It is well known that the industries implementing these practices have a positive impact on the organizational performance and profitability (Rehman et al., 2016; Seth et al., 2008). The visits give them a first-hand experience by observing such practices which include use of renewable resources, energy conserving designs, eco-friendly packaging, waste management and pollution control as per the laws. This sensitises them about the professional ethics and their role in the maintenance of a healthy society and sustainable environment. It also sets them thinking about the various careers in managerial and administrative roles. All this strengthening of industrial knowledge helps the students with better internship, project, and employment opportunities.

The success of any course depends on the attainment of the outcomes. Industrial visits generally do not have assessments in many educational institutes and measuring the outcomes has always been a challenge. Several workers have attempted to develop assessment schemes for industrial visits. Mahdi Al-Atabi et al. discussed the use of pre-visit, after-visit, and post-visit assessment in a study tour to a power plant for Engineering Design and Communication course (Al-Atabi et al., 2013). Markom et al. used a questionnaire to administer a post-visit survey to Chemical and Bioengineering students (Markom et al., 2011). The questions were linked to programme outcomes. Sen had conducted a post-visit survey for third year undergraduate students in the subject of Process Instrumentation and Control (Sen, 2013). Morgan et al. studied the students' perception about the site visits using the Kember Four-Category scheme for coding and assessing the level of reflection in written work (Morgan et al., 2021). Ssemakula et al. developed test instruments based on statistical methods to gauge the hands-on experience gained by the students in experiential education (Ssemakula et al., 2018). Boles et al. highlighted that if the outcomes are not clearly defined, then the assessment could lead to misleading results (Boles & Beck, 2005). Hence, to assess the tasks of observation, application, and reflection during a work-integrated-learning course, they had framed the outcomes using Bloom's Taxonomy. These outcomes evaluated the lower order thinking skills (viz. Remember, Understand and Apply) of the revised Bloom's Taxonomy(Anderson & Krathwohl, 2001). Mishra and Kotecha defined the learning outcomes for industrial visits like identifying the industrial processes for a particular product or service, understanding how the industry functions and relating engineering applications from industrial perspective. (Mishra & Kotecha, 2015).

Most of the literature mentioned above relies on the post visit questionnaire for the outcome attainment. Industrial visits have an immense potential in attaining the outcomes when connected to the classroom teaching. The current study tries to connect classroom instruction with the study tour to evaluate the outcomes of three subjects in a second-year undergraduate course in Chemical Engineering. It implements pre-visit, in-visit and post-visit activities for the outcome attainment.

2. Methodology

A study was carried out by the authors through two industrial visits to find out how the attainment of learning outcomes could be enhanced. The visits were conducted for the third-year students of the Chemical Engineering undergraduate course for two consecutive turns as shown in Table 1.

The first visit was conducted without any special pre-visit inputs. The feedback was taken from the students, and the analysis was done. Based on the lessons learnt in this visit, modifications in teaching method and tour conduct were proposed. These were implemented for the second visit and feedback was taken. The results obtained were analysed for outcome attainment and compared with the first visit.

3. Results And Discussion

A. Observations of Visit 1

The respondents were provided with a feedback form after the visit as shown in Appendix A.

One part of the form tested the cognitive course outcomes of the second-year subjects viz. Chemical Technology, Process Calculations, and Mechanical Operations through a quiz. Table 2 shows the course outcomes from the syllabus of each subject as well as the additional modified ones for the study tour purpose. The cognitive levels (CL) of the outcomes were as per the revised Bloom's taxonomy. The first additional learning outcome (ALO-1) was related to all the outcomes mentioned in the syllabus outcomes, in which the fundamentals learnt in class could be applied to the various activities in the industry. ALO-2 exclusively connected the classroom learning about unit operations and unit processes. ALO-3 helped identify the scale of the industry. The remaining ALOs, i.e., ALO4, ALO5, and ALO6, related to job profiles, safety concerns, and communication, could be attained only through the industrial visit. The questions were framed to understand how well the students had learnt in the classroom and were able to apply it in a real-world context. A target attainment of 75% was set. i.e., the outcome would be considered "attained" if 75 % of the respondents were able to answer the related questions correctly. The results, as shown in Table 4, suggested that the response was not good. The average attainment was 52.95% and hence the expected attainment of 75% was not met.

Further, the categories such as enjoyment, planning, and overall satisfaction throughout the visit were gauged through the feedback. As seen in Fig. 1, 88.2% of the students found the visit to be enjoyable and only 70% of students felt that the tour was well-planned.

Table 1 : Summary of The Industrial Visits Conducted

	Visit 1	Visit 2
Students involved	Third year undergraduate	Third year undergraduate
Tour Duration	07 days	06 days
Industries Visited	05	05
Sectors and Scale of Operation (Large-L, Medium-M, Small-S)	○ Bulk Chemicals (L) ○ Dye and Intermediates (M) ○ Pharmaceutical (M) ○ Food (L) ○ Petrochemicals (L)	○ Bulk Chemicals (L) ○ Dye and Intermediates (M) ○ Pharmaceutical (M) ○ Food (L) ○ Petrochemicals (M)
Total students on the tour:	57	41
Respondents for feedback:	51	35

Table 2 : Course Outcomes of The Subjects Covered In The Study Tour

Course outcomes from the syllabus
Course A: Chemical Technology A1. Identify the unit operations and unit processes involved in manufacturing processes (CL -2) A2. Enlist the various manufacturing routes for a product (CL-1) A3. Construct the block diagram and process flow diagram for a chemical process. (CL-3) A4. Apply principles of chemistry for a process (CL-3)
Course B: Mechanical Operations B1. Understand unit operations and their role in chemical engineering industries (CL-1) B2. Analyze the performance and power requirement of solid handling equipments. (CL-4) B3. Apply principles of settling, sedimentation, fluidization, and filtration for particle-fluid separation. (CL-3) B4. Select suitable solid-fluid separation equipment, conveyors, agitators, and mixers. (CL-4)
Course C: Material and Energy Balance C1. Perform material and energy balances for a given unit operation or process (CL-2) C2. Carry out degrees of freedom analysis. (CL -2) C3. Calculate utility requirements of a process. (CL -4) C4. Use modern software tools to solve material and energy balance problems. (CL-3)

Table 3 :Additional Learning Outcomes Covered In The Study Tour

ALO-1.	**Relate the fundamentals** learnt in the classroom with the operations in the industry. (CL -3)
ALO-2.	Identify the **unit operations and unit processes** in the industry. (CL-2)
ALO-3.	Differentiate between the **scale of operations** in the chemical industry. (CL -2)
ALO-4.	Identify the knowledge requirements for the various **job profiles** of a Chemical Engineer. (CL -2)
ALO-5.	Associate a pa rticular **safety** equipment or procedure to the respective health or environmental hazard/s in a chemical industry. (CL -2)
ALO-6.	Recognize the need for **effective communication** at the workplace. (CL-1)

Table 4 :Response to Questions on Cognitive Outcome Assessment'(visit 1)

Question	% Correct answers
How many batch processes did you see?	35.3 %
How many continuous processes did you see?	41.2 %
Which of the following unit operations could you see in the visit?	64.7 %
What were the job profiles of Chemical Engineers working in the industries you visited?	70.6 %

B. Research Questions

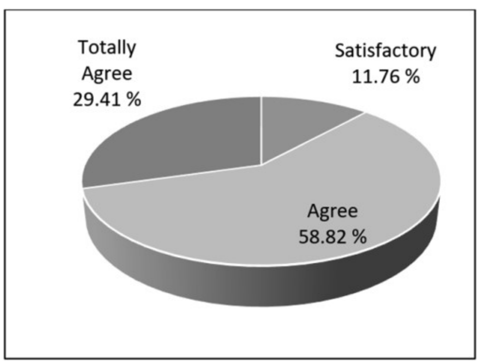
From the lessons learnt during Visit 1, following research questions were formulated:

1. A pre-visit activity to generate curiosity in the students is necessary to enhance the outcomes of the industrial visit.

2. Involvement of students in the tour planning makes the visit interesting, enjoyable, and conducive to learning.

C. The SEAR Method

To address the research questions mentioned above, a method was developed using Vygotsky's (Vygotsky, 1978) social constructivism principles. It said that "Cognitive development stems from social interactions from guided learning within the zone of proximal development as children and their partners' co-constructed knowledge." Also, it is well-known that learning does not happen unless curiosity is developed, and this has direct impact on the outcome attainment. Hence, we believe that students' outcome-oriented learning can be enhanced using the following steps: Stimulate, Experience, Assimilate/ Accommodate and Reinforce. This, we propose as the SEAR method, whose steps are given in Fig.2.



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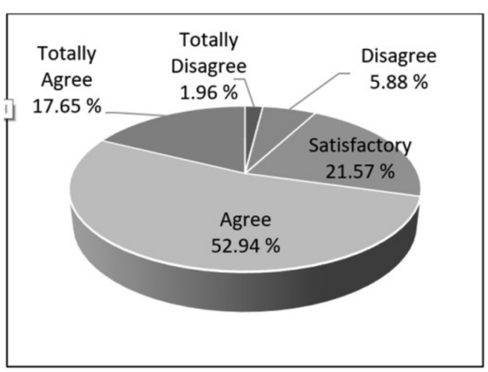


(b)

Fig.1. Overall Feedback for Visit 1 (a) The visit was enjoyable (b) The visit was planned properly

Step 1 (Stimulate): The pedagogy for classroom teaching was modified after the first visit. Students were exposed to the industrial environment through publicly available videos of manufacturing processes in the chemical industry. Through the assignments, they were introduced to the language of the industry by discussing case studies related to safety and the environment.

Next, a pre-tour quiz was given to the students. The purpose of the quiz was to lay the groundwork and pique the students' interest. This would help the students think about what they would see during the industrial tour. The usual experience is that most of the students are unprepared when they visit the industry. A few curious students show interest and ask questions. Hence, the questionnaire would develop interest in the students. The students would come to know the industrial terminology, which would help them understand the language spoken by the industrial personnel during the tour.

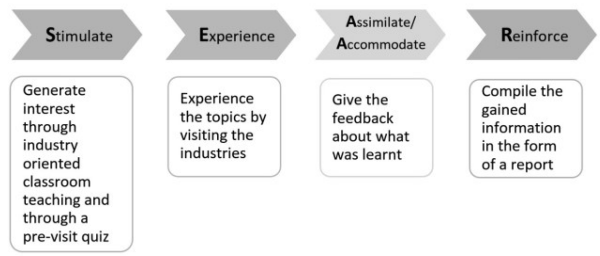


Fig.2 : Steps involved in student learning in an industrial visit (SEAR method)

This would also help them during their internship or employment interviews. For example, one of the questions asked in the questionnaire was, 'What is the pH of milk?' If the students were unable to answer the question, they would search for the correct answer on the internet, refer to books, ask their friends or personally check in the laboratory. Further, they would look for the process of controlling the pH when they visit the plant. They would interact with industry personnel and ask questions. Following Vygotsky's principle of constructivism, this social interaction would help in their cognitive development, leading to the attainment of the desired outcomes. The other questions were designed in an equivalent manner to stimulate them to think about it or ask questions to the industry personnel during the visit. This will keep them engaged during the visit and promote collaborative learning among the students.

Some sample questions are given in Table 5. The questions were designed such that they would address the additional learning outcomes (ALO) mentioned in Table III.

Step 2 (Experience): The students experienced the live environment of the chemical industry during the visit. They asked questions to the industry personnel and interacted with them to understand the industrial processes, logistics and managerial practices. This was in line with the principles of Dewey and Vygotsky stated below.

Dewey (Dewey, 1938) said that 'Learning is a social activity - it is something we do together, in interaction with each other, rather than an abstract concept'.

Vygotsky (Cole et al., 1978) further said that 'Every function in the child's cultural development appears twice: first, on the social level and, later on, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological).'

Step 3 (Assimilate/Accommodate): Post-visit feedback (same for both the visits) shown in Appendix A was administered. The stimulation from the pre-visit questions and the experience during the visit helped them to recall their observations easily. For example, the question about a particular job profile in the pre-visit questionnaire, stimulated them to think about other job profiles. They looked for such different profiles during the visit and, hence, were able to assimilate the knowledge about them as seen from the post-visit feedback.

This step uses the Jean Piaget's theory of cognitive development for assimilation and accommodation (Piaget, 1968). Assimilation occurs when a new idea fits in with the already existing ideas while, in accommodation takes place when the new idea changes the already existing ideas. Kim M et al have demonstrated the positive contribution of assimilation and accommodation in 736 students of entrepreneurial education (Kim & Park, 2019). Hanfstingl et al have performed a systematic literature review on various study areas that implemented the theory of assimilation and accommodation (Hanfstingl et al., 2022). They have studied 51 articles in the educational context that focussed on specific learning situations and general cognitive development.

Step 4 (Reinforce): To strengthen the knowledge gained during the visit, the students were asked to form groups of five members per group and prepare a comprehensive report on all the industries that they had visited during the tour. The points expected in the report were given to them as shown in Appendix B. This made them recollect their experiences during the tour and search for the unknown information from the company website, stock exchange, ministry of corporate affairs, etc.

This activity was thus designed to promote Collaborative Learning, Peer Assisted Learning (PAL) or Team Assisted Learning (TAL) among the

Table 5 :
Sample Questions From Pre-visit Questionnaire (Correct Answers Marked In Bold Font)

Question	Options given for correct answer	ALO addressed	Expected stimulation
API in a pharmaceutical domain stands for ________	a. American Petroleum Institute b. American Pharmaceutical Institute **c. Active Pharmaceutical Ingredient** d. Associated Pharmaceutical Ingredient	ALO-1	Think /ask about: What is/are the API used in the plant? What products are being manufactured using the same?
Chemical installations often employ gear pumps because they pump________ fluids.	**a. High viscosity** b. High density c. High pressure d. High temperature	ALO-2	Think/ ask about: What type of pumps are used in the plant What type of process fluid in transportation?
Natural draft cooling towers can be as high as 100 m or above.	**a. True** b. False	ALO-3	Think/ask about: What are the types of cooling towers and their dimensions?
The daily production of polyester chips in a chemical plant has been reduced by 3% over the last month. Who is responsible for the loss ?	a. Instrumentation Engineer **b. Production Shift Engineer** c. Operator d. All of these	ALO-4	Try to understand the roles of the various job profiles in the plant.
The wastewater stream from your plant has a BOD of 500 mg/l. What will you do?	a. Discharge it into the public sewers as it is b. Discharge it in inland waters like rivers **c. Treat it, bring down the BOD to 25 and discharge it discharge it** d. Treat it, bring down the BOD to 200 and discharge it	ALO-5	Think about/ ask about: What is the BOD? What is the BOD initially and after treatment? What treatment methods are used?

students for better outcome attainment. Several workers have discussed the importance of these pedagogies. Latjatih et al 2021 have implemented Peer Assisted Learning in a course for medical students (Latjatih et al., 2022). It was found that there was a significant improvement in their scores and 97% of the students found the method to be appealing. Nortcliffe et al have discussed the implementation of PAL for the underperforming Black British minority ethnics (BME) students in an engineering degree program. Their results indicated that there was a positive impact on their placements and internships attainment (Nortcliffe et al., 2022). Based on the study of 755 students, Simione et al have demonstrated the effectiveness of team-based learning in the area of interpersonal skills and abilities to manage interactions (Simione et al., 2017).

Further, a committee of ten students was formed to look into the detailed planning of the visit, including the choice of stay arrangements and food.

D. Observations of Visit 2

The results of the pre-visit and the post visit questionnaires were analyzed. From Fig. 3, it was seen that the outcome attainment increased post visit. Fig. 4(a) shows that all the students agreed that the visit to was enjoyable. 88.57% of students were happy about the planning of the visit as seen in Fig. 4(b). Thus, involving the students in the planning helped to enhance this experience. This was in line with the observations reported by Morgan et al. They had received suggestions that students should be allowed to choose the company rather than being assigned (M. Morgan and O'Gorman, 2017). From Table 6, it is observed that more than 65 % of the students were able to identify the types of processes correctly, and 75% students were able to identify/answer at least two unit operations per industry correctly.

The results for the identification of the job profile were encouraging, as 88.89% students identified it correctly. The result is in line with Morgan et al (2017) whose study found that 87% of their respondents understood the types of jobs in Engineering during the industrial visit (M. Morgan and O'Gorman, 2017). This will help them to look forward to their preferred work profile and concentrate their efforts in that direction. The overall results were found to be better than those in Visit 1 as the average outcome attainment was 77.78%.

E. Statistical analysis

A two-sample t-test assuming unequal variances was run to see if the findings were significantly different between the two visits.

Table 6 : Response To 'questions On Cognitive Outcome Assessment'(visit 2)

Question	% Correct Answers
How many batch processes did you see?	70.37
How many continuous processes did you see?	66.67
Which of the following unit operations could you see in the visit?	85.19
What were the job profiles of Chemical Engineers working in the industries you visited?	88.89

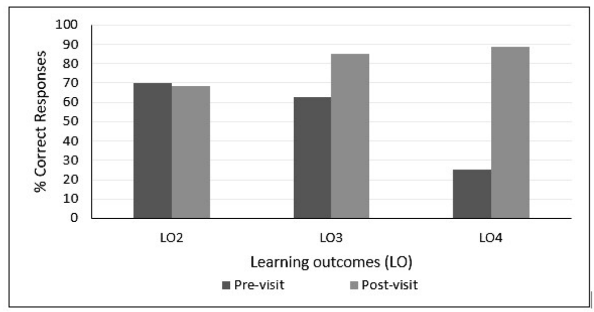
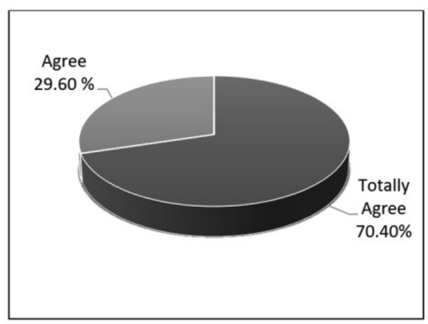
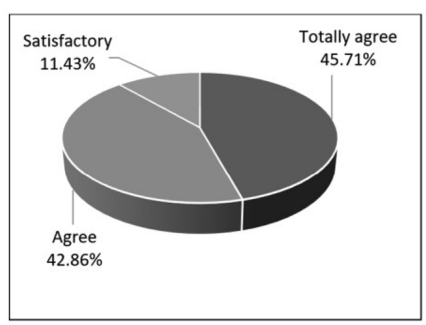


Fig.3: Comparison Of Results: Pre-visit And Post Visit Questionnaire



(a)



(b)

Fig.4 : Overall Feedback For Visit 2
(a) The visit was enjoyable
(b) The visit was planned properly.

Three feedback questions were considered for this.

1. How well were the fundamentals understood? (Knowledge gained by the students)

2. How well was the visit planned? (Planning and Scheduling)

3. How interesting were the aspects of the visit? (Overall satisfaction)

Feedback question 1 was related to research question 1 mentioned in Section 4 and the statistical results are shown in Table 7. Similarly, feedback questions 2 and 3 were related to research question 2. The results for these are shown in Tables 8 and 9.

The lower p-values for all factors in Table 7 except for exposure to the control room showed that the research questions asked were correct. It may be necessary to convey the principles of the control room in a different manner. Table 8 shows that the students did not find the accommodations comfortable during either visit, but they were happy with the modifications made for Visit 2.

Table 7 : Statistical Results for the Question 'How Well were the Fundamentals Understood?'

	Year	Mean	Variance	*p*-value
How many industries did you visit?	2019	4.98	0.02	0.00057
	2022	4·63	0·24	
How many batch processes did you see?	2019	4.06	0.66	0.00171
	2022	4.59	0.48	
How many continuous processes did you see?	2019	4.18	0.63	0.01680
	2022	4·56	0·49	
Which of the following unit operations could you see in the visit?	2019	4.53	0.49	0.04963
	2022	4.78	0.33	
What were the job profiles of Chemical Engineers working in the industries you visited?	2019	4.71	0.21	0.02194
	2022	4.89	0.10	
	2022	4.98	0.02	

Table 8 : Statistical Results for the Question 'How Interesting were the Aspects of the Visit?'

	Year	Mean	Variance	*p*-value
The visit was enjoyable!	2019	4.18	0.38	0.00004
	2022	4.73	0.22	
How interesting were the aspects of the visit related to Safety in the industry?	2019	3.81	0.84	0.00363
	2022	4.33	0.53	
How interesting were the aspects of the visit related to Industry Presentation?	2019	3.74	0.54	0.03372
	2022	4.07	0.45	
How interesting were the aspects of the visit related to the unit operations seen?	2019	3.86	0.72	0.06869
	2022	4.18	0.84	
How interesting were the aspects of the visit related to Control room exposure?	2019	3.62	0.95	0.34536
	2022	3.52	1.49	
How interesting were the aspects of the visit related to Quality control lab?	2019	3.55	1.29	0.00081
	2022	4.26	0.58	
How interesting were the aspects of the visit related to R & D?	2019	3.45	1.41	0.00302
	2022	4.11	0.71	

Table 9 : Statistical Results for the Question 'How Well was the Visit Planned?'

	Year	Mean	Variance	*p*-value
The visit was planned properly	2019	3.78	0.77	0.00094
	2022	4.37	0.47	
Were the core industries visited?	2019	4.04	0.60	0.01449
	2022	4.44	0.56	
Was the scheduling appropriate?	2019	3.59	1.09	0.01332
	2022	4.15	1.05	
Was the travel comfortable?	2019	3.47	1.01	0.05556
	2022	3.89	1.26	
Was the lodging comfortable and safe?	2019	3.92	1.07	0.12068
	2022	4.19	0.77	
Was the food quality good?	2019	3.27	1.36	0.00001
	2022	4.26	0.58	

Lower p-values in Table 9 show that the fundamentals were better grasped on the second visit, compared to the first. However, the knowledge about unit operations needed more clarity.

F. Other Comments

Some comments given by the students were as follows:

Student 1: “We were able to see large scale view of equipment- Reactors, Extraction and Distillation columns, QC lab”

Student 2: “The visit to ABC industry was the most beneficial for learning and a great medium for getting exposure to work profiles in an industry.”

Thus, they were able to identify and visualize the job profiles that they would be pursuing after graduation. This would help them choose their career path in an informed manner. Similar feedback has been reported by Carbone et al (2020), where the students, after visiting a company, said that they would be choosing hydraulic engineering as their career and were considering studying more courses in it. The site visits helped the students make decisions about their careers in hydraulic engineering.

On assessing the reports that were assigned to the students, it was found that they had divided the assigned industries amongst their members. Each of the members wrote the part assigned to them and explained it during the compilation of the final report. As expected, it promoted collaborative learning among them. This is in line with what Bates et al define as "Professional Purpose," made up of four mindsets: curiosity, action, collaboration, and growth. (Bates et al., 2019) This aided in addressing the soft outcomes of graduate attributes 3 and 4 given by Accreditation Board for Engineering and Technology (ABET, 2020) viz.

- "An ability to communicate effectively with a range of audiences."

- "An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives."

Feedback on food and travel, as well as disliked experiences, provided additional information.

Some of them said,

"The tour manager didn't arrange any local meals for us. The bus did not have comfortable seating arrangement. People with heights more than six feet had problems. The climate was very hot."

Another student said,

"No experience can be evaluated as "bad." 1-2 cases of miscommunication did happen, but that did not cause any major upset, and it these things do happen when managing 41 children! So overall, none!"

Whatever the students' preferences were, it provided them with exposure to a multicultural environment, which is an important graduate attribute for professional development. (ABET, 2020).

4. Limitations of the Study

Sample size: Since the sample sizes were different, the results may have some bias. Nonetheless, the study well records the overall perception of the students as well as the outcome attainment as seen statistically.

Number of students involved in planning: As only ten students were involved in the planning of the tour, the other students did not get a chance to enhance their soft skills. The greater the student involvement in planning, the greater the likelihood of achieving the soft outcomes.

Cognitive levels addressed: The questionnaires consisted of questions that belonged to cognitive levels 1,2 and 3 of Bloom's taxonomy. This did not give an insight into the outcome attainment for higher cognitive levels.

5. Conclusion

The pedagogical method named Stimulate-Experience-Assimilate/Accommodate-Reinforce (SEAR) has been proposed. It combines different pedagogies like the traditional classroom instructions, inquiry-based learning, experiential learning and collaborative learning. The efficacy of the method in enhancing the outcomes of the industrial visits has been demonstrated through a case study. Both academic and soft outcomes were found to be effectively addressed. Better planning and execution of the study tour led to a better learning environment and, hence, enhanced outcomes. Similar exercises can be performed by including other subjects in the outcome assessment. Furthermore, the questionnaires can be tailored to address higher cognitive levels. Although, the method has been demonstrated for the engineering discipline, it can be extended to other disciplines. This will help to strengthen the theoretical knowledge learnt in the classroom and make the students profession-ready and employable.

APPENDIX

A. Post visit feedback questionnaire

Kindly give honest feedback. Note that this feedback is not graded since it is anonymous. Please tick () at your chosen scale wherever applicable. (1=Totally disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Totally agree) for questions 1, 2, 3, 4

1. The visit was enjoyable
2. How interesting were the aspects of the visit?
   a) Safety in the industry
   b) Industry Presentation
   c) Unit Operations
   d) Control room
   e) Quality control lab

f) R & D

3. The visit was planned properly.
4. Feedback on planning

a) Were the core industries visited?

b) Was the scheduling appropriate?

c) Was the travel comfortable?

d) Was the lodging comfortable and safe?

e) Was the quality of food good?

5. How many industries did you visit?
6. How many batch processes did you see?
7. How many continuous processes did you see?

Industry name	Job profiles
a)	
b)	
c)	
d)	
e)	
f)	

8. What were the job profiles of Chemical Engineers working in the industries you visited?

Unit Operation	Which industry?	What was the system? (Feed, products, etc)
Distillation		
Drying		
Extraction		
Absorption		
Crystallization		
Size reduction		
………..		
………..		

9. Which of the unit operations could you see on the isit?
10. What was the best thing that you liked on the tour?
11. Any bad experiences on the tour?
12. Any other comments.

B. Points expected in final report

About the Industry

1. Name of the Industry:
2. Address:
3. Sector (Fine chemicals, bulk chemicals, food, petrochemicals, etc):
4. Scale of operation (Small/Medium/Large):
5. Nature of production (Continuous/Semi-batch/Batch):
6. Any certification (ISO, HACCP, etc.):
7. Number of employees:
8. Major clients/market:

Manufacturing process

1. Principal products:
2. By-products (if any):
3. Area of the plant:
4. Capacity of the plant:
5. Brief History
6. Licensors of the processes:
7. Process flow diagram:
8. Major Unit Processes (Give the chemical reactions)
9. Major Unit Operations (Give the capacities of each. Describe the types used)

Material Handling and Storage

1. List the material handling equipment in the plant.
2. From where were the raw materials obtained?
3. How were the raw materials stored? Mention the special temperature, pressure conditions or any special precautions taken.
4. How were the products packed? Explain the procedure.
5. How were the products shipped out of the plant?

Quality Control/Research and Development

1. Was there a quality control lab in the plant?
2. Was the lab certified by any recognized government agency?
3. What were the major testing/analysis equipment available in the lab?
4. Which materials were tested? (Raw materials, in-process material or final product)
5. Was there a routine test procedure available? If yes, what was the frequency of sampling?

6. What were the actions taken for non-conforming samples? Were the batches rejected, recycled or isolated?

Health, Safety and Environment (HSE)

1. What were the safety measures used in the plant?
2. What were the waste products generated?
3. How were these products disposed?
4. Was there an Effluent Treatment Plant in the premises?
5. If yes, mention the type/process in brief.

Economics

1. What was the cost of raw material?
2. What was the cost of the product?

Engineering Problems

1. What major engineering problems did you observe in the plant/operations?
2. Give suggestions if any for overcoming these problems.

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