

## Research Article

# Enhancing Students' Performance in Heat and Mass Transfer Course through Active Learning Methods - A Case of Jimma Institute of Technology, School of Chemical Engineering, Ethiopia

Abreham Bekele Bayu<sup>1\*</sup>, Samuel Gessese Filate<sup>1</sup>, Tarkegn Kumela Hundie<sup>2</sup>

<sup>1</sup>School of Chemical Engineering, Jimma Institute of Technology,  
Jimma University, Jimma, P.O.Box 378. Ethiopia,

<sup>2</sup>Faculty of Civil and Environmental Engineering, Jimma Institute of Technology,  
Jimma University, Jimma, P.O.Box 378. Ethiopia.

\*Corresponding author's e-mail: [abrishchem@gmail.com](mailto:abrishchem@gmail.com)

## Abstract

The general objective of this research study is enhancing students' performance in heat and mass transfer course through active learning methods. The methodology for the study conducted were longitudinal study design since it takes a five month interventions in delivering the course by using active learning methodologies together with tutorials. The study population and the target groups were also identified by the support and cooperation given from JiT registrar. Before the study was started all the necessary conditions were done such as providing orientation, fixing the duration of the study, and rearrangement of the program as per the interest of most of the students. The sampling technique used was availability sampling. The sample size was included for year II both female and male students of Heat and Mass transfer course students in second semester of 2018. After this pilot study or post-secondary data was collected from JiT registrar office and questionnaires collected from the students; we reach on the problem of the nature of the course. Therefore, we conclude that the study output indicates that the percentage of passed students increased from 64.11% to 80.95% after active leaning methodology or HDP program training has given for instructors in addition to delivering on spot tutorial. The group study recommends that active leaning methodology can enhance the performance of the students and the school should have to emphasis on this methodology in addition to monitoring and appreciating on spot tutorial.

**Keywords:** Active learning; Heat and mass transfer; Students performance; Chemical Engineering.

## Introduction

Heat and mass transfer is one of the basic and common courses that is delivered in JiT under school of chemical engineering. It is a pre-requisite and compulsory course to the majority of the courses offered under the school of chemical engineering. Thus, in some cases it is mandatory first to obtain passing grades in this course to continue studying the subsequent courses. Consequently, many number of students enrolled every year to take heat and mass transfer course as part of their course. Most of JiT students in chemical engineering fail in heat and mass transfer course as such documents' from JiT the registrar depicts that in academic year 2014/15 to 2017/18.

In heat and mass transfer course the following data were obtained as in 2014/15, 30 students scored F grade out of 160 students which is 18.75 %, 2015/16, 40 students were scored F grade out of 155 students which is 25.80%, 2016/17, 25 students were scored F grade out of 170 students which is 14.71 % from three consecutive years. From these mentioned data the research team decided to conduct an action research on heat and mass transfer course in the school of chemical engineering [1].

Heat and mass transfer course is one of the subjects recognized as a major factor in development and technological transformation that attracts the attention of policy maker to make it part of the national agenda to focus in this [2]. Performance of the school in all levels,

the kind of teacher quality and its teaching output became a national priority in addressing the quality of education. Low achievements in many areas are now the concern for all academic and government institutions. Therefore, revisiting how the way students learned and the way students' achievement was performed is an effort worthwhile to consider [3].

In majority of our schools, Heat and mass transfer course is considered as a challenging subject, which the reasons cannot be understood by students, teachers and parents. However, it is a common phenomenon around the globe. Heat and mass transfer course is considered by many individuals as a difficult subject to master. This kind of outlook has a direct relation with achievement. Specially, students with negative attitudes towards heat and mass transfer have performance problems because they develop anxiety. Thus, if this problem continues to develop in their academic progress, it will affect their performance in subject containing to master and computation [4].

The core tenet of active learning is that providing students with opportunities to actively engage with content during their classes leads to positive learning outcomes. Active learning is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing.

While this definition could include traditional activities such as homework, in practice active learning refers to activities that are introduced into the classroom. The core elements of active learning are student activity and engagement in the learning process. Active learning is often contrasted to the traditional lecture where students passively receive information from the instructor [5]. Within the active learning approach the learner actively constructs their understanding of Heat and Mass transfer concepts in an iterative fashion. In this case the word iterative means that the structure and content of the teaching process is enhancing procedural (being sure of which steps to take) and conceptual (to know the meaning, to know why the steps are taken) knowledge to evolve simultaneously. Hence a more and more complex cognitive network of relationships between different pieces of heat and mass

information is forming in the mind of the learner. The cognitive network includes knowledge of both procedures and concepts, knowledge that is connected in ways that give the learner both a good intuitive feel for the course and a good problem-solving and answer-generating capacity [6]. According to literature active learning approach can be explained by using four core statements as described as follows [7,8].

- i. The learner is the key-person in the active learning process, i.e. Heat and Mass course teaching should be learner-centered.
- ii. The Teacher is an authority because of his/her knowledge of both Heat and mass transfer learning and his/her respect for the learners as thinking and socially active individuals.
- iii. Open-ended and rich in learning tasks are considered a prerequisite for the possibility of constructing a conceptually rich cognitive structure and a relational understanding of heat and mass transfer concepts.

The set-up of the classroom should support interaction in small groups, whole-class discussion and individual seatwork in accordance with the needs of the learner and the learning task.

## **Research design and methodology**

### **Research aims**

The overall aim of this research is

- i. To identify the extent to which students performance in heat and mass transfer course
- ii. To evaluate the impact of active learning methods on the students heat and mass transfer course.
- iii. To scrutinize the effectiveness of teaching methodology in the improvement of students' result in heat and mass transfer course.

To enhance students' performance in Heat and Mass transfer course through active learning methods, first I should confirm as students fail on heat and mass transfer course by preparing research questions and questioner. Before assessing the problem it is better to know the problem which makes the heat and mass transfer course failures.

### **Research questions**

Research questions are based on questionnaire to conduct required research. Research questions are given below.

1. To what extent active learning methods measures the progress of students' result in heat and mass transfer course?
2. What is the impact of implementing active learning methods on the students' performance in heat and mass transfer course?
3. What can be done to improve the result of students' heat and mass transfer course?

### **Questionnaire**

1. What was your favorite subject as a high schooled?
2. Are you placed in a campus of your choice?
3. If your answer to Q 2 is no, where did you wanted to join?
4. Are you placed in the college you were planning to join?
5. If your answer to Q 4 is no, which college you were planning to join?
6. Are you in the engineering field of your interest?
7. If your answer to Q 6 is no, which engineering field you were planning to join?
8. Why are you not in the field of study of your interest?
9. Are you satisfied by the field of study you are placed (chemical engineering)?
10. If your answer is no for Q 9, What is your doubt about the field?
11. Which course did you find the most difficult one in this semester?
12. What do you think is the reason behind the difficulty?
13. What would you find to be helpful to overcome this difficulty?

### **Data collection and experimental design**

A Survey of four years secondary data was collected on the results of students registered in Jimma University institute of technology in school of chemical Engineering. The study conducted were longitudinal study design since it takes a five month interventions in delivering the course by using active learning methodologies together with different instructional media. The study population and the target groups were also identified by the

support and cooperation given from JiT registrar. Before the study was started all the necessary conditions were done such as providing orientation, fixing the duration of the study, and rearrangement of the program as per the interest of most of the students. Finally, the delivery of the course was accomplished and conducting continuous assessment was done according to the time frame allocated.

### **Study parameters**

The Study area was Jimma University institute of technology (JiT) under the school of chemical engineering. The target population was all students who took Heat and Mass transfer course in the past four years moreover; the study population was all students who scored F or failed in Heat and Mass transfer particular course.

### **Sample size and sampling technique**

The sampling technique used was availability sampling. The sample size was included both female and male students who scored "F" grade in Heat and Mass transfer from the population of year two in second semester.

### **Data analysis**

The collected data was fully analyzed using Microsoft office Excel 2007-2013 software. Thus this application software was selected as the data of students was 105.

### **Identification of the problem**

The total numbers of students registered for an action research are 105 which completed the program successfully. The following graph shows the relationship between scored F against registered one on the course heat and mass transfer for three years starting from 2014 /15 till 2016/17.

From figure 1 it is observed that there is much number of students who failed to pass heat and mass transfer course for the consecutive three years starting from 2014/15 till 2016/17. This forced us to take an action on this course.

The data in table 1 were taken through questioner from 105 second year chemical engineering students who had taken the course heat and mass transfer course for 2017/18 academic year.

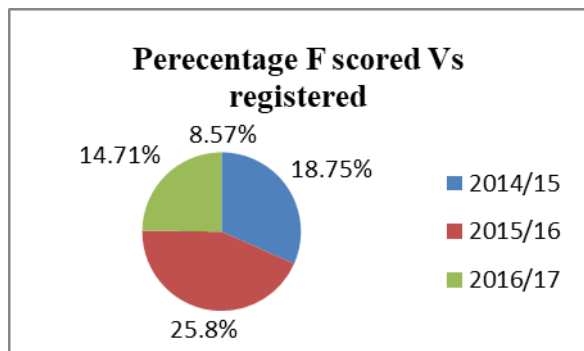


Figure 1. Percentage of “F” scored against registered on the course heat and mass transfer

Table 1. Number of respondent for course difficulty

Sl. No.	Course name	No of students respond for its difficulty	Rank for difficulty
1	Heat and mass transfer	15	1
2	Organic chemistry	14	2
3	All course	13	3
4	Numerical methods for chemical engineers	12	4
5	Fluid mechanics	10	5
6	Chemical engineering thermodynamics I and II	12	4
7	No course	5	8

From the table 1, it can be concluded that 15 students respond for the course heat and mass transfer course difficulty. When we compare with other courses the number of student's respondent for heat and mass transfer difficulty is higher. Therefore heat and mass transfer course is the course which needs remedial action in the school of chemical engineering.

From the above table 2 the reason behind the difficulty of the course heat and mass transfer is the nature of the course. Because 8 students respond as the nature of the course out of 15 students. Therefore the problem is related with the nature of the course. Therefore it was believed that giving tutorial for the students was of utmost paramount.

Table 2. Number of respondent for the reason behind difficulty

Sl. No.	The reason behind difficulty	No of students respond for its difficulty from 15 students	Rank for difficulty
1	The nature of the course	8	1
2	Other	5	2
3	Instructor's approach	3	3

### Results and discussion

As the information gained from the table 1 to 3 the helpful way to overcome the difficulty with heat and mass transfer course is giving tutorial. Because from table 3.1 seven students respond as the way to overcome the difficulty is getting tutorial.

### Actual performance

From the treatment group, all of them were taken from 2017/18 batches. In 2017/18, totally 105 students have taken the course heat and mass transfer, out of these (105) 19.05 % of them fail to score pass grade. Hence, 105 of them were registered as a treatment group. The following table summarizes the comparison of pass and failures for the four successive years starting from 2014/15 till 2017/18.

Table 3. Number of respondent for the helpful ways to overcome the difficulty

Sl. No.	Helpful ways to overcome this difficulty	No. of students respond for helpful ways	Rank for difficulty
1	If I could get tutorial	7	1
2	If I could get additional supportive material	4	2
3	If the instructor's approach is changed	3	3
4	Other	1	4

From the table 4 we conclude that the number of pass increased from 64.12% to 80.95% comparing academic year of 2016/17 to 2017/18. In another way the number of fail reduced by 16.83% after taking an action.

Table 4. Scored grades with percentage for 2014/15-2017/18

Years	No. of students	Scored grades with % of age						No. of Passed	
		F	%	D	%	C-	%		
2014/15	160	30	18.75	24	15	24	15	82	51.25%
2015/16	155	40	25.80	27	17.41	18	11.61	70	45.16%
2016/17	170	25	14.71	16	9.41	20	11.76	109	64.12%
2017/18	105	9	8.57	5	4.76	6	5.71	85	80.95

From the figure 2 and table 5, we conclude that the number of fail is reduced from 14.71% to 8.57% from the year 2016/17 to 2017/18 after taking an action. The table 6 shows the detail information of the 2016/17 academic year grade for 170 students in this course. For summary for the table 6, the table 7 is prepared. The table 8 shows the detail information of the actual grade of treatment group in this course. For summary for the table 8, the table 9 is prepared.

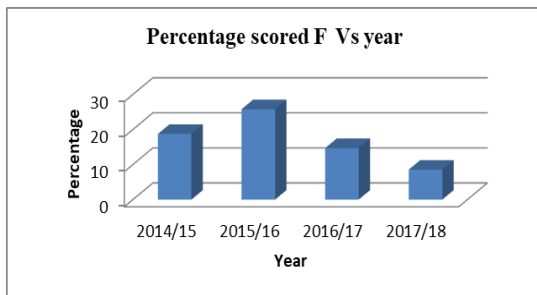


Figure 2. Percentage of failed students with respective years

Table 5. Percentages against scored F in year

Year	2014/15	2015/16	2016/17	2017/18
Percentage	18.75	25.8	14.71	8.57
F scored	30	40	25	9
Registered	160	155	170	105

Table 6. Detail profile of students' grade for academic year of 2016/17

Sl. No.	Grade scale	Letter grade	Sex		Total
			Male	Female	
1.	[90-100)	A+	5	2	7
2.	[85-90)	A	20	10	30
3.	[80-85)	A-	10	4	14
4.	[75-80)	B+	4	2	6
5.	[70-75)	B	5	2	7
6.	[65-70)	B-	10	4	14
7.	[60-65)	C+	11	4	15
8.	[50-60)	C	10	6	16
9.	[45-50)	C-	15	5	20
10.	[40-45)	D	10	6	16
11.	[30-40)	FX	0	0	0
12.	[0-30)	F	18	7	25
Total			118	52	170

Table 7. Summary of students

Sex	Passed	Fail	Total
Male	75	43	118
Female	34	18	52
Total	109	61	170

Table 8. Detail profile of students' performance for academic year of 2017/18

Sl. No.	Grade scale	Letter grade	Sex		Total
			Male	Female	
1.	[90-100)	A+	4	1	5
2.	[85-90)	A	20	10	30
3.	[80-85)	A-	5	2	7
4.	[75-80)	B+	4	2	6
5.	[70-75)	B	4	2	6
6.	[65-70)	B-	5	2	7
7.	[60-65)	C+	6	2	8
8.	[50-60)	C	10	6	16
9.	[45-50)	C-	4	2	6
10.	[40-45)	D	3	2	5
11.	[30-40)	FX	0	0	0
12.	[0-30)	F	5	4	9
Total			70	35	105

Table 9. Summary of students

Sex	Passed	Fail	Total
Male	58	12	70
Female	27	8	35
Total	85	20	105

The experiment conducted show as it is tabulated from the above table 3.5 up to table 3.8, in academic year of 2016/17, from 170 students 61 of them fail to score pass grade, this implies more than one third of them (61) (35.88%) fail to score pass grade. In another way 109 (64.12%) of them were passed the course. But in academic year of 2017/18 from 105 students (20) (19%) of them only fail to score pass grade that means 85 (80.95%) of them were passed the course. This indicates that the

percentage of students in academic year of 2017/18 who failed in this course is reduced by 16.88 % comparing with that of 2016/17 after taking an action.

In another expression the action research conducted has shown that, from 105 students 85 (80.95%) of them score pass grade, this implies that only 9 of them (8.57%) scored F grade in 2018. But in 2017 from 170 students 109(64.11%) of them get score pass grade, this implies that 25 of them (14.71%) scored F grade. Therefore, this indicates that the percentage of passed students increased from 64.11% to 80.95% after active leaning methodology or HDP program training has given in addition to giving tutorial.

### Conclusions

Majority of the students engaged in this action research were committed to perform good result. As professional commitment all the necessary preparation and pedagogically sounded active methodology were implemented for wellbeing performance of the treatment group. As a result great change was observed and most of the students were motivated in the delivery of the course in the usage of teaching aid and on spot tutorial delivery. However, due to certain constraints like class sizing, frustration about the course as being they took twice or three times and thus, the intended result were not attained. The research team wants to conclude that most of the treatment group was taken this course at least twice before this program was conducted, that means all of them scored F grade twice. But by conducting active learning method and giving tutorial, almost all of them 85(80.95%) were get pass grade out of 105 students in 2018 after HDP training. Thus the active leaning method together with teaching aid can enable and facilitate the performance of students in Heat and Mass transfer course.

### Conflict of interest

Authors declare no conflicts of interest.

### Acknowledgement

The authors' wish to give sincere thanks to Jimma University School of Chemical Engineering and second year chemical engineering students for allowing us to fill the questioner for performance of students in Heat and Mass transfer course.

### References

- [1] Jimma University, Jimma Institute of Technology, Office of Registrar, Documents of 2014-2018.
- [2] Johnson L, Adams Becker S, Estrada V, Freeman A. NMC Horizon Report: 2014 K-12 Edition. The New Media Consortium. Austin, Texas: 2014.
- [3] Boud D. Enhancing learning through self-assessment. Rutledge, London. 2013.
- [4] Ministry of Education Addis Ababa Ethiopia., Higher Diploma Programme for teacher educators. 2011; p. 94-115.
- [5] Spike BT. An investigation of the knowledge, beliefs, and practices of physics teaching assistants, with implications for tax preparation. 2014.
- [6] Assefa A, Tilahun B. Predictors of self-reported academic performance among undergraduate medical students of Hawassa University, Ethiopia. *Advances in Medical Education and Practice* 2015;6:305
- [7] Kirkwood A, Price L. Missing: Evidence of a scholarly approach to teaching and learning with technology in higher education. *Teaching in Higher Education*, 2011;18(3):327-37.
- [8] Chi MT. Active-constructive-interactive: A conceptual framework for differentiating learning activities. *Topics in Cognitive Science* 2011;1(1):73-105.

\*\*\*\*\*