Journal of Engineering Education Transformations ,
Volume 37 , No. 4 , April 2024 , ISSN 2349-2473, eISSN 2394-1707

10.16920/jeet/2024/v37i4/24167

Investigating the Impact of EMU8086 Emulator on Developing Positive Student Attitude Towards Assembly Language Programming

Dr. R Mathur
Department of Electronics and Communication Engineering, Manipal University Jaipur,
Dehmi Kalan, Jaipur, Rajasthan, INDIA. 303007.
er.rohit.mathur.ind@gmail.com

Abstract : This article presents the findings of an experiment designed to explore whether the utilization of a teaching aid, in this case the emulator EMU8086, can positively influence the target undergraduate students' attitude towards acquiring 8086 assembly language programming skills or not? Methods: Twenty-nine students participated in a one-day hands-on workshop. The sessions focused on 8086 assembly language programming using the EMU8086 emulator. All twenty-nine participants submitted pre- and post-workshop polls. For analyzing the pre- and post-workshop poll data, a matched-pair Wilcoxon signed-rank test was utilized. Results: The average confidence level of participants in their capability to create an assembly language program by themselves doubled from 1.7931 ± 0.1437 to 3.7586 ± 0.1071 (P = 4.68957E-21). The average confidence level of participants in the EMU8086's capability to assist in learning 8086 assembly language programming increased from 2.6207 ± 0.1749 to 3.9655 ± 0.0782 (P = 4.34958E-11). The average participant interest in similar skill enhancement opportunities soared from 3.2759 ± 0.1395 to 4.6897 ± 0.0874 (P = 5.25141E-14). The average participant interest in the domain of embedded systems slightly increased from 4.3103 ± 0.1005 to 4.6897 ± 0.0874 (P = 0.000145533). Conclusions: The findings suggest that exposure to the EMU8086 emulator had a positive impact on participants' attitude towards acquiring assembly language programming skills. Relevance: Identifying the factors that drive interest in the domain of embedded systems which may help attract a larger consortium of potential learners and even lower the dropout rate.

Keywords : 8086, microprocessor, attitude, assembly language programming, confidence, EMU8086, emulator

I. Introduction

The Indian government has been focusing on the domain of embedded systems in recent years (India, 2020b, 2020a). The Ministry of Electronics and Information Technology (MeitY) has launched several initiatives to promote the growth of the embedded systems industry in India. The Electronics Development Fund (EDF) is one such initiative that

Dr. R Mathur
Department of Electronics and Communication Engineering,
Manipal University Jaipur,
Dehmi Kalan, Jaipur, Rajasthan, INDIA. 303007.
er.rohit.mathur.ind@gmail.com

provides funding to startups and companies working in electronics and IT sectors, including those working on embedded systems (Ministry of Electronics & Information Technology, 2023).

The responsibility of preparing a workforce that would help achieve national interest falls on the educational institutes imparting professional courses. Thus, professional courses in the domain of electronics and allied domains like Bachelor of Technology and other undergraduate and postgraduate level courses must incorporate a course on microprocessors (Logozar, Horvatic, Sumiga, & Mikac, 2022). The course should aim to co-develop relevant software and hardware skills (Cadenas, Sherratt, Howlett, Guy, & Lundqvist, 2015), as well as to establish a technological foundation for research and development (Knight & Russell, 1985). The hardware part focusing on the interfacing the microprocessor with relevant hardware (JingYu, 2022). The software part primarily focuses on honing the skill of assembly language programming (ALP) (Metri, Bharathpulavarthi, Srikanth, & Bhattar, 2018).

Learning and implementing ALP is a complex task (JingYu, 2022), as a result it is not perceived as an obvious choice for programming hardware, despite its advantages (Xu, 2022). The use of technology based educational tools like simulators (Ghosh & Konguvel, 2022; Qaralleh & Darabkh, 2015) and emulators for teaching ALP have been explored since its origin (Gray, 1985; Oo, Soe, & Khaing, 2020). Many studies have demonstrated increase in self-reported interest in various specialties after using such educational tools (Ghani, Enzai, & Ahmad, 2018; JingYu, 2022). One such study reported that the use of Edulent simulator in teaching, helped participants to learn Intel assembly language more easily (Mezei, 2020).

The purpose behind conducting this work was to explore whether the utilization of the emulator EMU8086 can positively influence the target undergraduate participants' attitude towards acquiring assembly language programming skills.

2. Materials And Methods

All participants underwent a one-day workshop on EMU8086. Participants were made aware of this event through their respective class WhatsApp groups. The workshop was conducted in two phases. Phase one focused on the EMU8086 emulator's introduction, its features, its capabilities, and implementing basic assembly language structures in the emulator. Phase two, conducted during the second half of the day, aimed at developing confidence in participants. This was achieved by allowing participants to create an ALP of their choice and debug the program using EMU8086 until the program ran perfectly without errors and produced the desired results. All participants were required to complete the pre- and post-workshop poll questionnaire, consisting of the same questions. This research work was carried out in January 2023.

A. Emulator

For this investigation, the EMU8086 emulator was employed. EMU8086 is specifically designed for 8086 microprocessors. It is integrated with the 8086 assembler (Qaralleh & Darabkh, 2015) and free tutorials (Zhang, Sang, Luan, & Zhu, 2022). It provides valuable feedback to participants while they learn about the mistakes made in a particular line of code, which the process of a dry run does not provide for (Oo et al., 2020). It also allows participants to execute the program line by line (single-step execution). Which in turn assist in analysing changes after the execution of each line of ALP (Zhang et al., 2022). Thus, empowering participants with valuable insights about the relevant internal units thereby enhancing the learning not just about the instruction's working but also about the internal architecture's working of the 8086 microprocessor (Al-Haija, Al-Abdulatif, & Al-Ghofaily, 2013).

B. Participants

Volunteers were required to be undergraduate students pursuing a Bachelor of Technology in Electronics and Communication Engineering at the institution where the study was carried out. Twenty-nine undergraduate students pursuing a Bachelor of Technology in Electronics and Communication Engineering willingly took part in this study. The participants were not compensated for their participation in any way, including marks or perks. Table I presents the demographic data of the participants.

TABLE I: Participants' demographics

S. No.	Parameter	Value
1.	Gender (Male : Female)	23 : 06
2.	Past Experience of EMU8086 (Yes : No)	01 : 28
3.	UG Students' Year of Study	2nd and 3rd year

C. Pre-Workshop Poll Questionnaire

All participants completed the pre-workshop poll questionnaire, consisting of four questions. A five-point Likert scale poll was devised (Jarrah, Al-Salman, & Haider, 2023; Xiberta, Thio-Henestrosa, Fontas, & Boada, 2022) by the author for this study on the basis of the scholarly work presented by Grim et al (Grim, 1936). The responses were ranked between 5 (strong yes) and 1 (strong no) (Gallet et al., 2021; Mezei, 2020).

The questions used for the study are as follows:

Q1) How confident are you in your ability to create an assembly language program on your own?

Q2) How confident are you in EMU8086's capability to help you learn 8086 assembly language programming better?

Q3) How likely are you to attend similar trainings?

Q4) How interested are you in having a career in the domain of embedded systems?

D. Protocol

All participants were required to complete the pre-workshop poll questionnaire before the start of the workshop. Then each participant took part in the workshop. After the completion of the workshop, all the participants were required to submit the post-workshop poll questionnaire.

E. Post-Workshop Poll Questionnaire

After completing the sessions, all the participants then submitted the post-workshop poll questionnaire. The poll consisted of the same four questions as the pre-workshop poll questionnaire.

F. Data Analysis

The pre- and post-workshop poll questionnaire response data was collated, and the poll data was analysed using a matched pair Wilcoxon signed rank test in MS Excel (Šinkovec, Trobec, Kamenski, Jerman, & Meglič, 2023). The post-hoc power analysis for the poll data was conducted using G*Power (Escamilla-Martínez et al., 2023). The power analysis was done using an α of 0.05, calculated Cohen's constant (dz), a total sample size of 29, and one tail to check whether or not the sample size was sufficient for the experiment. The dz was calculated using the poll data with the help of G*Power. The post-hoc analysis indicated that the minimum required sample size should be 26 participants. The participant number for the study was 29, thus more than the required number. Therefore, the results of the study are statistically acceptable.

3. Results

The poll data is presented as means ± SE with confidence intervals (P(T<=t) one-tail). P values less than 0.05 were deemed vital.

A. Confidence in self

The average confidence level of participants in their own capability to create an assembly language program by themselves doubled from 1.7931 ± 0.1437 to 3.7586 ± 0.1071(P = 4.68957E-21)(Table II, Fig. 1).

Table 2: Confidence in self

Linkert Scale Value	Pre-Session	Post-Session
1	11	0
2	14	0
3	3	9
4	1	18
5	0	2

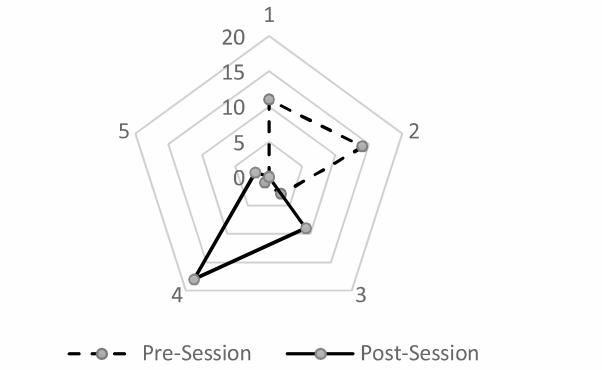

Fig. 1 : Confidence in self.

B. Confidence in EMU8086

The average confidence level of participants in EMU8086's capability to assist in learning 8086 assembly language programming increased from 2.6207 ± 0.1749 to 3.9655 ± 0.0782 (P = 4.34958E-11) (Table III, Fig. 2).

Table 3: Confidence in EMU8086

Linkert scale Value	Pre-Session	Post-Session
1	2	0
2	13	0
3	9	3
4	4	24
5	1	2

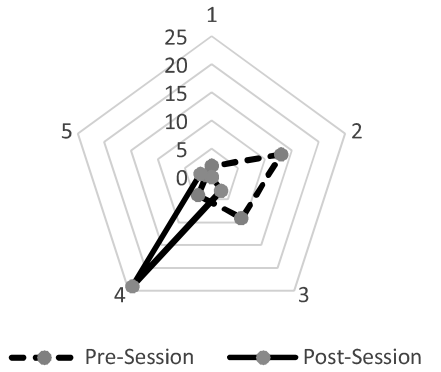

Fig. 2 : Confidence in EMU8086.

C. Interest in similar skill enhancement opportunities

Data indicated that the participants were more likely to attend similar skill enhancement opportunities after going through the workshop. The average participant interest in similar skill enhancement opportunities increased from 3.2759 ± 0.1395 to 4.6897 ± 0.0874 (P = 5.25141E-14) (Table IV, Fig. 3).

Table 3: Interest in Similar Skill Enhancement Opportunities

Linkert scale Value	Pre-Session	Post-Session
1	0	0
2	4	0
3	14	0
4	10	9
5	1	20

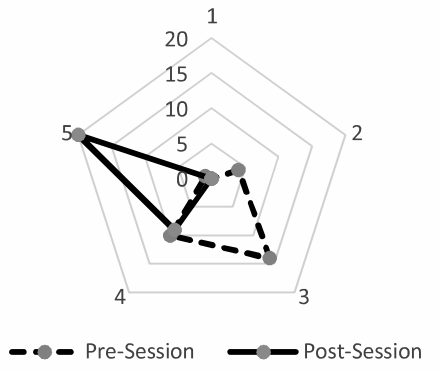

Fig. 3 : Interest In Similar Skill Enhancement Opportunities.

D. Opinion regarding career in Embedded Systems

It was also observed that the use of the EMU8086 emulator increased participants' interest in the domain of embedded systems. The average increase observed was from 4.3103 ± 0.1005 to 4.6897 ± 0.0874 (P = 0.000145533) (Table V, Fig. 4).

Table 5 : Opinion Regarding Career in Embedded Systems

Linkert scale Value	Pre-Session	Post-Session
1	0	0
2	0	0
3	1	0
4	18	9
5	10	20

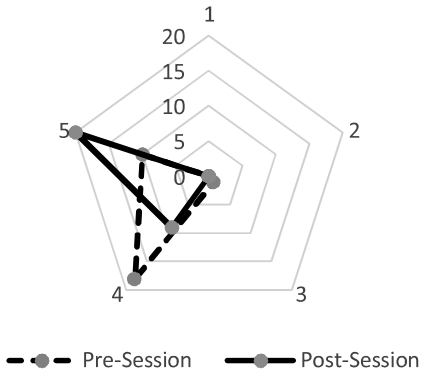

Fig. 4 : Opinion Regarding Career in Embedded Systems.

4. Discussion

Creating the first ALP can be a daunting task for a novice, as too many things can go wrong, from mnemonics to addressing modes. Thus, learners have difficulty gathering sufficient confidence to even attempt to write ALP. The findings of this study indicate that acquaintance with EMU8086 increased participants' confidence and interest in acquiring assembly language programming skills. The participants chose programs to execute on the emulator independently and used the emulator confidently to execute the ALPs.

Software tools have been available for teaching assembly language programming, but the learning curve from the perspective of the learner is mostly steep (Diab & Demashkieh, 1991). It was observed during the sessions that participants became familiar with EMU8086's user interface quickly. This not only strengthened their confidence in EMU8086 but also enabled them to explore on their own. Participants learned debugging using the single-step execution feature available in EMU8086 and corrected mistakes from their own experience with little or no instructor's intervention.

Their confidence in EMU8086's utility in enhancing their assembly language programming skills increased significantly, unlike previously conducted work using QEMU (Cadenas et al., 2015).

The findings of this study further strengthen the fact that the use of educational tools, software, and hardware (Cadenas et al., 2015), during the study positively influenced trainees. Even to the extent that trainees take up a career in the respective domain (Mezei, 2020). As per the reported results, exposure to EMU8086 had a positive impact on their probable future skill enhancement opportunities in embedded systems and a career possibility.

The findings from this work are encouraging and indicate that there will be better engagement of current and future participants with educational tools like EMU8086.

5. Limitations

Nonetheless, it ought to be noticed that there are a few limitations to the reported work. To begin with, almost certainly, members were keen on the domain of embedded systems when contrasted with the overall general participants, as they belonged to the undergraduate program in electronics. This is reflected in the pre-test poll reactions. Though this impediment doesn't diminish the discoveries of this work, The participants interest in embedded systems is additionally fortified.

Albeit the study has confirmed an increase in participants interest in having a career in embedded systems, the number of these participants who would actually go on to pursue careers in embedded systems cannot be determined as of now.

Besides, this study occurred at a specific academic establishment with a somewhat small sample size. In this manner, it isn't known whether these outcomes would be replicable as is over a larger scope.

6. Conclusion & Further Work

The results of this study and few other recent studies indicated that the use of educational tools, EMU8086 in this case, helps in building better foundational concepts (Kanika, Chakraverty, & Chakraborty, 2021; Xu, 2022).

The outcomes of this study exhibit that acquaintance with the EMU8086 emulator has boosted the undergraduate electronics participants interest in assembly language programming skills and boosted their confidence in the EMU8086 emulator as a learning tool. A longitudinal study shall be conducted to test whether participants do take up a career in the domain of embedded systems or not.

Acknowledgment

The author expresses sincere gratitude to the head of the department for permitting the conduct of the aforementioned workshop. The author would like to thank the support staff of the Microprocessor and Microcontroller Laboratory, SEEC, MUJ, for assisting in conducting the workshop, collecting data from individual student questionnaire responses, and transforming it into an operable MS Excel data set. The author would also like to thank all the participants of the workshop for their sincere participation. Finally, the author would like to thank Director SEEC and MUJ Leadership for their constant encouragement and support for this work.

References

[1] Al-Haija, Q. A., Al-Abdulatif, S., & Al-Ghofaily, M. (2013). An 8-bit Scientific Calculator based Intel 8086 Virtual Machine Emulator. Procedia Computer Science, 21, 506–511. https://doi.org/10.1016/j.procs.2013.09.070

[2] Cadenas, J. O., Sherratt, R. S., Howlett, D., Guy, C. G., & Lundqvist, K. O. (2015). Virtualization for Cost-Effective Teaching of Assembly Language Programming. IEEE Transactions on Education, 58(4), 282–288. https://doi.org/10.1109/TE.2015.2405895

[3] Diab, H. B., & Demashkieh, I. (1991). A computer-aided teaching package for microprocessor systems education. IEEE Transactions on Education, 34(2), 179–183. https://doi.org/10.1109/13.81598

[4] Escamilla-Martínez, E., Sánchez Martín, F., Ramos-Ortega, J., González-García, P., Cortés-Vega, M. D., & Fernández-Seguín, L. M. (2023). Age related changes in the Q angle of non-professional football players. Heliyon, 9(6), 4–9. https://doi.org/10.1016/j.heliyon.2023.e16781

[5] Gallet, P., Rebois, J., Nguyen, D. T., Jankowski, R., Perez, M., & Rumeau, C. (2021). Simulation-based training in endoscopic endonasal surgery: Assessment of the cyrano simulator. European Annals of Otorhinolaryngology, Head and Neck Diseases, 138(1), 29–34.

https://doi.org/10.1016/j.anorl.2020.08.012

[6] Ghani, M. A. H. A., Enzai, N. I. M., & Ahmad, N. (2018). Effect of using simulator as teaching aid on microprocessor course performance. IEEE Student Conference on Research and Development: Inspiring Technology for Humanity, SCOReD 2017 - Proceedings, 2018-January, 215–219. https://doi.org/10.1109/SCORED.2017.8305391

[7] Ghosh, A., & Konguvel, E. (2022). ATM Services on EMU8086 for the Technologically Impaired People. 2022 International Conference on Computer Communication and Informatics (ICCCI), 1–7. https://doi.org/10.1109/ICCCI54379.2022.9740885

[8] Gray, N. A. B. (1985). A computer simulator for use in an introductory course on computer systems and assembly language programming. Computers and Education, 9(3), 155–163. https://doi.org/10.1016/0360-1315(85)90002-8

[9] Grim, P. R. (1936). A Technique for the Measurement of Attitudes in the Social Studies. Educational Research Bulletin, 15(4), 95–104. Retrieved from http://www.jstor.org/stable/1471067

[10] India, G. of. (2020a). Modified Electronics Manufacturing Clusters (EMC 2.0) Scheme.

[11] India, G. of. (2020b). Scheme for Promotion of manufacturing of Electronic Components and Semiconductors (SPECS).

[12] Jarrah, S., Al-Salman, S., & Haider, A. S. (2023). Video Games Localization into Arabic: Gamers' Reactions to Localizing PUBG and Free Fire. Journal of Social Computing, 4(1), 74–93. https://doi.org/10.23919/JSC.2023.0004

[13] JingYu. (2022). Construction of Assembly Language Three-tier Experimental System Based on EMU8086. ISCTT 2021 - 6th International Conference on Information Science, Computer Technology and Transportation, 9, 272–276.

[14] Kanika, Chakraverty, S., & Chakraborty, P. (2021). A peer-assessment based approach for teaching microprogramming. Journal of Engineering Education Transformations, 34(4), 7–12. https://doi.org/10.16920/jeet/2021/v34i4/146148

[15] Knight, J. C., & Russell, J. L. (1985). Software development tools for microcontrollers. Software: Practice and Experience, 15(5), 459–472. https://doi.org/10.1002/spe.4380150505

[16] Logozar, R., Horvatic, M., Sumiga, I., & Mikac, M. (2022). Challenges in Teaching Assembly Language Programming – Desired Prerequisites vs. Students' Initial Knowledge. 2022 IEEE Global Engineering Education Conference (EDUCON), 2022-March(March), 1689–1698. https://doi.org/10.1109/EDUCON52537.2022.9766737

[17] Metri, R. A., Bharathpulavarthi, V. R. S. V., Srikanth, I., & Bhattar, C. L. (2018). Microcontroller laboratory practices through project-based learning. Journal of Engineering Education Transformations, 31(3), 169–178.

[18] Mezei, I. (2020). Evolution of an educational microprocessor. Computer Applications in Engineering Education, 28(5), 1265–1277. https://doi.org/10.1002/cae.22300

[19] Ministry of Electronics & Information Technology, G. of I. (2023). Electronics Development Fund (EDF) policy. In meity.gov.in. Retrieved from https://www.meity.gov.in/esdm/edf

[20] Oo, S. H., Soe, K. T. T., & Khaing, K. M. (2020). TEACHING OF 8088 / 86 PROGRAMMING WITH 8086 ASSEMBLY EMULATOR TEACHING OF 8088 / 86 PROGRAMMING WITH 8086. 2019 Joint International Conference on Science, Technology and Innovation, Mandalay, (April), 731–737. Mandalay.

[21] Qaralleh, E. A., & Darabkh, K. A. (2015). A new method for teaching microprocessors course using emulation. Computer Applications in

Engineering Education, 23(3), 455–463. https://doi.org/10.1002/cae.21616

[22] Šinkovec, M., Trobec, R., Kamenski, T., Jerman, N., & Meglič, B. (2023). Hemodynamic responses to low-level transcutaneous auricular nerve stimulation in young volunteers. IBRO Neuroscience Reports, 14(January), 154–159. https://doi.org/10.1016/j.ibneur.2023.01.010

[23] Xiberta, P., Thio-Henestrosa, S., Fontas, J., & Boada, I. (2022). The Experience of Using a New e-Learning Tool in Architectural Studies. IEEE Access, 10(August), 87008–87021. https://doi.org/10.1109/ACCESS.2022.3198977

[24] Xu, X. (2022). Teaching Reform of "Microcomputer Principle and Application" Course for OBE. OALib, 09(12), 1–9. https://doi.org/10.4236/oalib.1109408

[25] Zhang, Y., Sang, S., Luan, Y., & Zhu, X. (2022). Application of Emu8086 in Digital Teaching Mode of Microcomputer Principle and Interface Technology. International Journal of Education and Humanities, 6(1), 158–161. https://doi.org/10.54097/ijeh.v6i1.3083