New After-Class Assignments Options for Electronic Circuit Courses in Digital Era

Ming Luo[a], Jianxun Zhao[b*]

Xidian University, Xi'an, Shaanxi, 710071, China

[a]mluo@xidian.edu.cn, [b]*jxzhao@xidian.edu.cn

Abstract. After-Class Assignments (ACA) is an important part of the university course. After presented multiple functions of ACA and the characteristics of learning processing of students in the digital era, challenges of ACA in the digital information age are investigated. Then, according to learning theory and Feynman Learning Technique, a new ACA Option for electronic circuit courses is proposed, including a plan and detail process for analog circuit course. Finally, the effect of the new ACA is evaluated in two dimensions: students' acceptance and the spread of scores in the Final Evaluation. Final results supported that the new ACA can enhance student learning and increase pass rates, it should be a better alternative to traditional ACA.

Keywords: After-class Assignments, Learning Theory, Feynman Learning Technique.

1 Introduction

After-Class Assignments (ACA) in undergraduate education is necessary and import part of course and primary means to train students to analyze and solve problems independently. ACA should fulfill the three basic functions: Consolidating learning content, facilitate independent study and feedback status of learner.

In the digital era of education, the Internet provides numerous high-quality learning resources, for example, course videos, lecture notes, course ware, simulation cases, experimental cases, engineering cases, etc. [1] Meanwhile, reference materials, such as solutions to exercises, are also available on the Internet, and it is easy for students to collect and make use of such rich learning materials from various internet platforms [1]. Therefore, conventional ACA show their weakness in such information era as discussed below.

1.1 Single Level Homework Can't Fit for Different Students' Background

Good students will find a significant gap between the learning resources offered in the digital age and the uniformly assigned after-school homework, while few students without ability even look up the answers to their assignments directly from the Internet.

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1.2 Limited Interaction of Traditional After-Class Assignments

The traditional open-loop ACA follow this processing: "handing in -> correction -> return and feedback", such process cannot fully achieve the goals of homework, and the correction of homework should be incorporated into the closed-loop of homework interaction. Therefore, the content and processing of after-class homework need to be innovated and adjusted in digital era in order to fully realize three basic functions of ACA (Consolidating learning content, facilitate independent study, and feedback status of learner).

The paper designs a new type of ACA, the new method adopts output-oriented learning method (Feynman Technique) as the theoretical basis, allow full participation of students during the correction and revision of the homework, focusing on "learning" of student, and form a closed-loop the process of homework on student end. It is expected to overcome the problems of single level and limited interaction of traditional ACA method. The new type of "Lecture and Practice(L&P)" homework is expected to match the background of digital era, and can better realize the functions of ACA which emphasized in previous section.

2 Design & Practice of New ACA

2.1 Learning Theory for New ACA

In 1946, Edgar Dale [2], a scholar of education, put forward the theory of "Cone of Learning" (Cone of Learning), believing that "efficient learning is output active learning"[3]. The learning pyramid for language learning, for example, is shown in Figure 1, which shows that the average retention rate of learning content increases significantly with the change in learning mode from listening and reading to lecturing, and that active learning significantly improves learning efficiency over passive learning.

As a matter of fact, it is written in the Book of Rites and Records of Learning [4]: " Therefore, when one learns, one knows that there is insufficiency; when one teaches, one knows that there is difficulty. After learning, one can realize one's insufficiency, and after teaching, one can realize one's difficulties. Therefore, it is said that teaching and learning are mutually reinforcing". It reads: "Learn and then know what is insufficient, teach and then know what is confusing to you. Knowing the insufficiency, you can urge yourself to learn further; knowing the confusion, you can make progress, so that: teaching and learning are mutual promotion and common improvement."

Follow this theory, students should be allowed to act as not only "receivers" of knowledge but also "dissemination" of knowledge, taking basic learning as a starting point, continuing to tell others, and discovering their own shortcomings in the process, so that they can be supplemented and improved, and ultimately build their own knowledge system. This output-oriented approach to learning [3] is also known as the Feynman Technique [3,5,7]. The technique enables learners to discover a concept independently and choose their own best approach to arrive at the desired outcome. It is a self-determined learning strategy that emphasizes critical thinking.

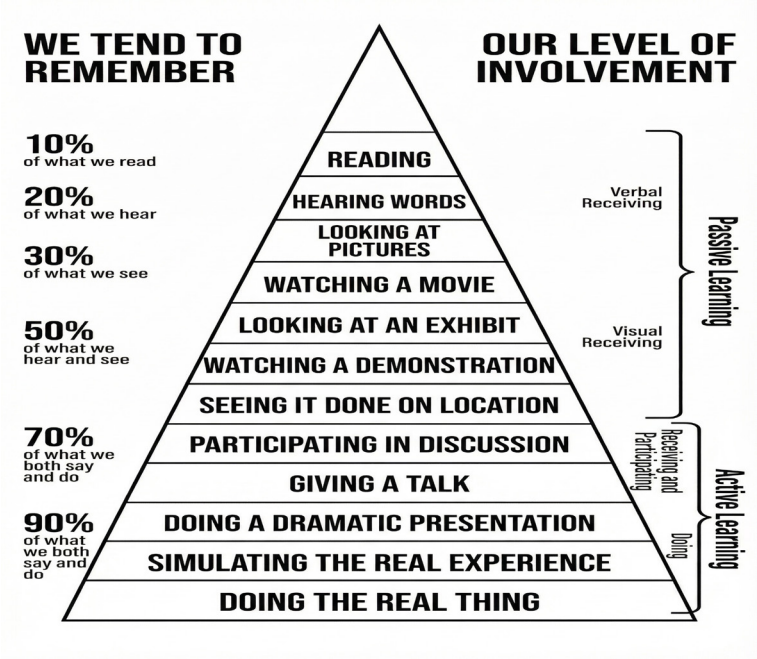


Fig. 1. Cone of Learning, From Reference [1]

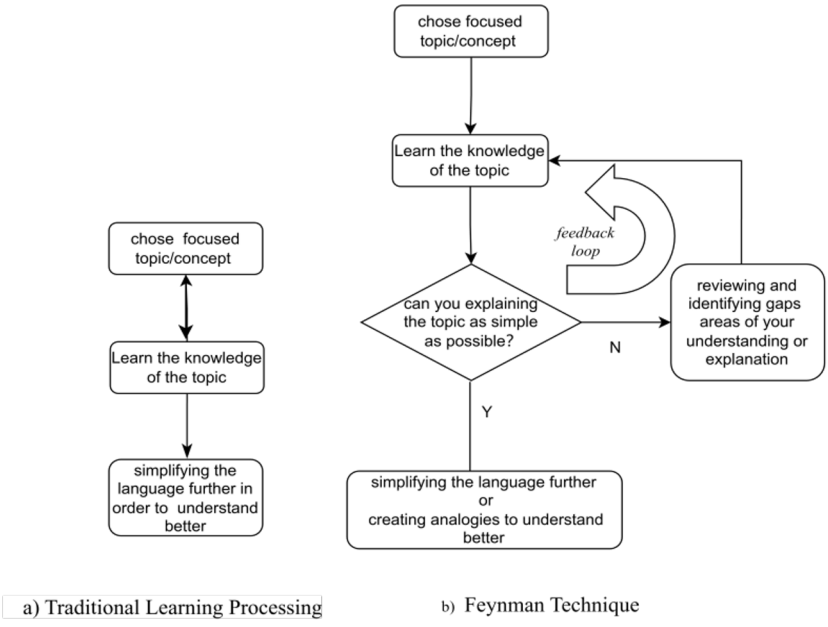


Fig. 2. Traditional Learning VS Feynman Technique

Compared with the traditional learning method (in Figure 2), the output-oriented learning method establishes the feedback loop (shown in Figure 2) according to the teaching effect of learner, therefore can effectively construct knowledge system.

2.2 Design of New ACA

The new "Lecture and Practice (L&P)" ACA adopt previous Learning Theory, and designed with output-oriented approach. The procedure of new homework is outline as below.

Topic Assignment. The new L&P ACA require condensing the curriculum, bringing together the difficulties and key points of the course, refining the content so as to determine the content and form of the L&P ACA, and formulating assignment topics that cover the content of the course, then releasing the assignment topics to the college students.

Group and Video Lectures. College students should be divided into learning groups, each complete their own assignments independently, then they are required to give lectures to others in the group on the topic of the assignment. They should prepare their video lectures which should involve the key points and difficult points of the course contents, and then published on the homework web platform [6] in order to evaluated by others students.

Anonymous Peer Evaluation. Anonymous peer evaluation of their lecture is done by other students on the homework web platform [6]. During the preparing stage, college students had to learning corresponding knowledge or concept in order to give the lecture, they will identify and locate their deficiencies or conceptual ambiguities. When they evaluate other's homework, each student needs to determine whether other's methods are correct or not, therefore they have to review the knowledge or concepts again. In short, they have to engage in knowledge output when evaluating homework assignments, such procedure will be consolidating learning content and facilitate independent study.

At last, the instructor reviews the lecture videos, the assessment results, and this step realizes the function of feedback on students' status in the post-course assessment. The new type of ACA promotes students to think independently, students have to judge and evaluate the work of others, thus provoking discussion and practicing critical thinking.

3 Implementation and Effectiveness

In order to evaluated the effectiveness of New ACA, we conduct a survey by questionnaire on the web. We also test it in one of four similar classes denoted as A, B, C, D. The student number in each class are 96, 95, 96, and 93, students in all four class have similar background and they all major on same subject. Class A is class which apply new ACA method and other three class use other homework method.

3.1 Students' Feedback on the Survey

Survey Question: Do you think the "Lecture and Practice" ACA carried out in this semester is helpful to you?

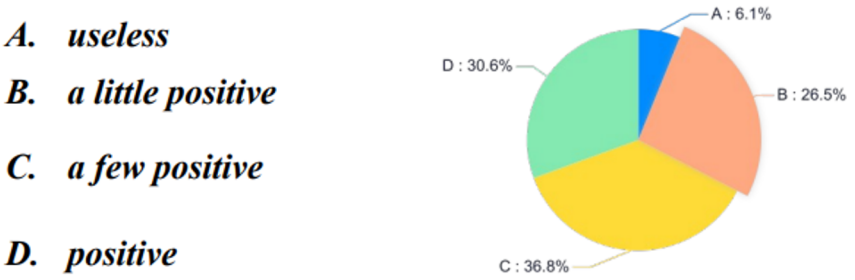


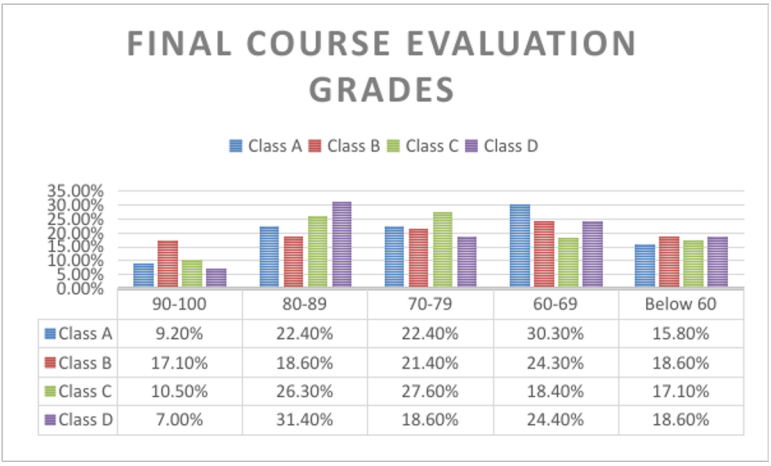
Fig. 3. Result of Students' feedback on the survey (From Web Survey DATA)

In the feedback data shown in Figure 3, nearly 93% of the students gave positive comments on the "Lecture and Practice" assignments. The data show that most students are motivated to accept and participate in the instructional activities and benefits of the new assignments. During the talks between student and teacher, the student representatives said: "After participating in the "Lecture and Practice" assignments, they were able to clearly perceive the deficiencies in their knowledge in terms of coverage and depth during the preparation stage of the lecture, accurately position and make up for the deficiencies, and they were able to assess their mastery of knowledge and check for gaps in their knowledge in the execution stage of the lecture and peer evaluation. The new ACA is an effective tool to help them assessing the state of their knowledge and identifying gaps." The new ACA is student-centered, it designed with Output-Oriented Learning Theory, it is conducive to improving students' self-perception of their learning status, which leads to "catching up" on weak points.

3.2 Impact on Final Evaluation Grades

The grade of all class is shown in Figure 4. Compare to the other three classes, more students in Class A passed in final course evaluation, it means that new homework method can promoting students with average learning foundations and low motivation to learn.

The Fail and Excellent rate of all Class is plotted and compared in Figure 5. As in the Figure 5, although Class B has the highest excellent rate, its failure rate is the highest at the same time, and the polarization is obvious. Among all the four Class, Class A grades are the most evenly distributed (9.2% excellent and 15.8% fail), such data also imply that new ACA is an effective method for student with different background. In the next step, we consider grouping students according to their basic situation, and setting different difficulty levels for different groups in the new ACA, so that students with different background can achieve more improvement.



	90-100	80-89	70-79	60-69	Below 60
Class A	9.20%	22.40%	22.40%	30.30%	15.80%
Class B	17.10%	18.60%	21.40%	24.30%	18.60%
Class C	10.50%	26.30%	27.60%	18.40%	17.10%
Class D	7.00%	31.40%	18.60%	24.40%	18.60%

Fig. 4. Comparison of the spread of grades for different class (From Final Exam. Data)

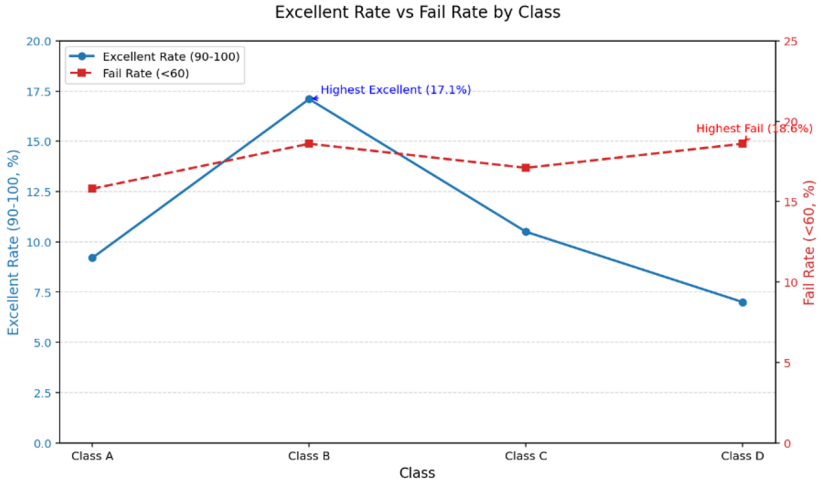


Fig. 5. The Fail rate and Excellent rate of Four Class (From Final Exam. Data)

4 Conclusion

In the digital era of education, the Internet can provide numerous high-quality learning resources. After present the problems of traditional homework, a new "Lecture and Practice" ACA is designed and applied in analog circuit course. The effect of new ACA is evaluated by student survey and analysis of grade of final evaluation; the results approve that new assignments can be a better alternative to traditional ACA because it promotes student learning and increase pass rates. Next, how to integrate Artificial Intelligence tools such as LLM (Large Language Model) with the new ACA will be considered [7].

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References

1. Hartog, M., Mulder, B., & Hoetjes, I. (2014). Structural adoption of web lectures in higher educational programmes: impact on quality of teaching and learning. Annual Conference of the European Group of Public Administration International Institute of Administrative Sciences, Speyer, Germany. https://interoperableeurope.ec.europa.eu/sites/default/files/document/2016-05/egpa_psgix_2014_paper_hartog_et_al.pdf
2. Lee, E., & Reeves, T. C. (2011). A Significant Contributor to the Field of Educational Technology. Educational Technology,51(1), 56–58. http://www.jstor.org/stable/44429901
3. Qi, H., Kui, X., Zhong, P., & Xiong, S. (2021). Study on the Application of Learner's Output-oriented Feynman-Five-Energy Method in Computer Teaching. _2021 16th International Conference on Computer Science & Education (ICCSE)_, 292–295. https://doi.org/10.1109/ICCSE51940.2021.9569508
4. Zhang, Y., Bai, Y. (2015). The Chinese Classic Philosophy of Learning and Teaching: Exploring Insights of the "Essay on Learning". In: Khine, M. (eds) Science Education in East Asia. Springer, Cham. https://doi.org/10.1007/978-3-319-16390-1_4
5. Reyes, E., Blanco, R. M. F., Doroon, D. R., Limana, J. L., & Torcende, A. M. (2021). Feynman Technique as a heutagogical learning strategy for independent and remote learning. Recoletos Multidisciplinary Research Journal, 9(2), 1–13. https://doi.org/10.32871/rmrj2109.02.06
6. XdSpoc. (n.d.). Online web lectures service. https://xdspoc.xidian.edu.cn/
7. Rajesh, A., & Khan, S. (2024). Learn Like Feynman: Developing and Testing an AI-Driven Feynman Bot. 2024 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE),1-8. https://doi.org/10.1109/TALE62452.2024.10834370