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USE OF E-LEARNING AND COURSE ASSIGNMENTS TO IMPROVE LEARNING EFFECTIVENESS IN CONSTRUCTION PROJECT PLANNING

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Abstract

Construction project planning integrates various types of theoretical knowledge and practical skills in civil engineering, and learning effectiveness among students is often diminished by a lack of real construction work experience. This research describes the design of a series of course assignments for construction project planning instruction, integrated with the use of e-learning tools. Following the semester-long course, a questionnaire is used to assess learning outcomes. Findings show that the course assignments significantly improve learning outcomes and that learners find the e-learning tool to be convenient and helpful in developing autonomous learning abilities through solving course assignment problems. In addition, as smart phones have emerged as a mainstream e-learning device, the user interface of instructional content must be modified for optimal effectiveness on smart phones. The research findings are integrated and enumerated as an instructional framework reference for the subject of Construction Project Planning.

Keywords

Learning Effectiveness, E-Learning, Course Assignment, Construction Project Planning

1. Introduction

Construction project planning is a civil engineering course that combines basic theory and practical applications. To perform well in the course, learners need construction site work experience and a fundamental understanding of basic construction methods. Students without practical work experience will have difficulty applying abstract theoretical concepts. In particular, modern construction project planning has undergone dramatic changes in terms of learning processes and the application automation and informationization. However, (Nattiv, 1986) pointed out that traditional teacher-dominated instructional methods treat a class of students as a single monolithic entity, and minimize interaction among students or with the teacher, thus limiting effective acquisition of teaching content. (Tsai, 2001) suggested that traditional teaching methods follow course book content, and the learning process among students in largely passive. However, such traditional teaching methods are being disrupted by the surge of information made available by advances in information technology. This has put the traditional "transmission-reception" instruction model under considerable stress. Given changing learning conditions, teachers must consider how to best develop student abilities, and teaching concepts, methods and media must adapt to the needs of the times (Willis, & Dickson, 1997). Given the needs of a new digital-native generation, teaching models must be updated to integrate a variety of new tools, with appropriate activities to enhance learner motivation and interest.

To respond to changes in students' learning needs, considerable research has been conducted on teaching methods. (Bermejo et al., 2017) used a role-play activity to transform conventional classes based on simple problem solving, and active playful activity was found to successfully increase student participation in learning. (Slavin, 1987) described Cooperative Learning as a systematic and organized means of developing social communication skills, and can transform students from passive to active learners, enhance learning performance, and improve interpersonal communication skills and relationships. In the process of Cooperative Learning, students can organize and share their knowledge with classmates and learn from others (Shimazoe, & Aldrich, 2010). Cooperative learning enables students to develop social and communications skills during the learning process, benefiting both students and teachers (Munir et al., 2018). (Burron et al., 1993) found that, students taught using Cooperative Learning methods outperformed those using traditional teaching methods in terms of academic achievement, along with cooperation skills and attitudes.

The media of learning have also undergone a significant transformation through the development of sophisticated information technologies, including digital teaching materials and the internet. (Laadem, 2017) indicated that the appropriate integration of online activities into instructional process can enhance learning performance. (Johnson et al., 2008) found that online environments can facilitate creating and finding learning materials, and increase learning interactivity among students. Compared with traditional teaching methods, the use of digital technologies can allow the use of a wider range of media (Ajournalarticle et al., 2002), thus better stimulating learner engagement, enhancing learner comprehension of abstract concepts, and increasing learning performance. As a result, the uses of digital technologies have emerged as mainstream educational practice, enhancing teaching performance and learning outcomes. (Liao, & Hsieh, 2014).

The above suggest that the students generally have positive perceptions of interactive learning styles and specific forms of teaching materials, along with digital, online learning environments. This study applies Cooperative Learning methods to the design and application of coursework for different class units in a construction project planning course, creating digital teaching materials to enhance learner performance. The trial was conducted during a one-semester course, after which questionnaires were used to assess learner performance and perceptions.

2. Methodology

This research is conducted in the context of a required Construction project planning course in a university department of civil engineering. The course presents a series of learning activities to help students understand the progress of civil engineering projects scheduling and the associated financial planning, and to develop relevant management skills. The course content is highly practical and applied. To allow students without relevant work experience to access the course content and thus enhance learning outcomes, seven learning units are developed to follow the course content, as shown in Figure 1 Each unit includes assignments based on course content, and guides students in the use of digital learning tools to facilitate peer discussion, and to actively seek out solutions, thus triggering learning motivation and improving learning outcomes.

Figure 2 shows the execution of the teaching activities. First, the concept and basic knowledge for each course unit are taught through traditional instruction methods. After the unit

is completed, students engage in classroom work. Course assignment content includes a review of current course knowledge and the application of this knowledge in practice. This encourages students to enhance learning performance through real-time practice. The digital learning materials are online resources that facilitate autonomous learning and assignment completion.

Study participants included 33 fourth-year civil engineering majors. All participants completed a one-semester learning activity, after which results and perceptions were assessed through a questionnaire. Mid-term and final exam grades were compared to assess the impact of learning activities on learning outcomes, as a reference for the future design of learning activities and course material.

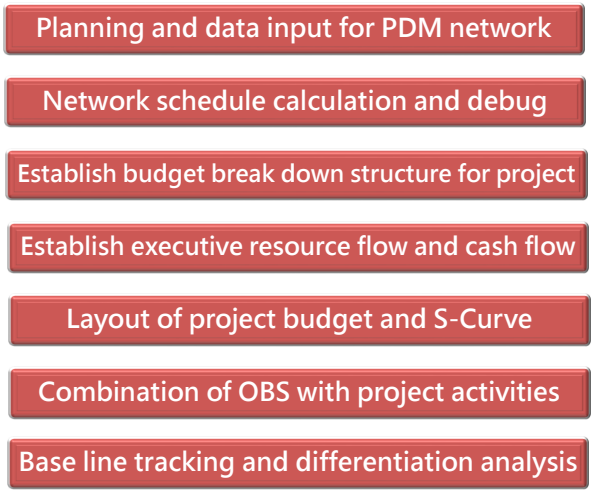

Figure 1: *Construction Project Planning Course Units*

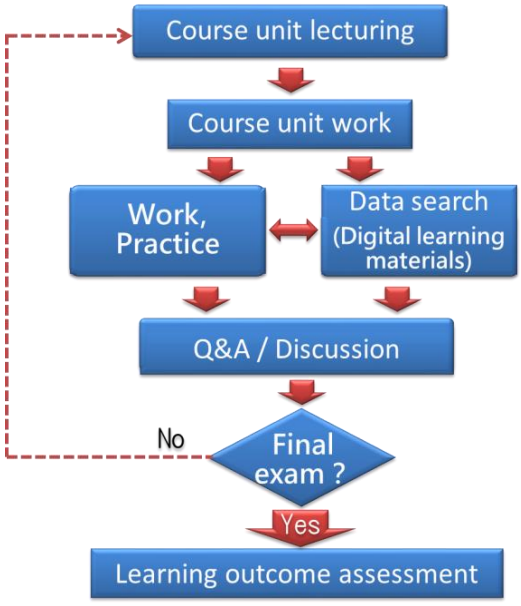

Figure 2: *Construction Project Planning Course Execution Flow*

3. Results

Figure 3 shows the distribution of learner test results. Scores are divided into three grades (high, medium and low), and are analyzed in the context of the questionnaire results. The relevant analysis results are organized according to three items: digital learning materials, course unit operation and curriculum activity design.

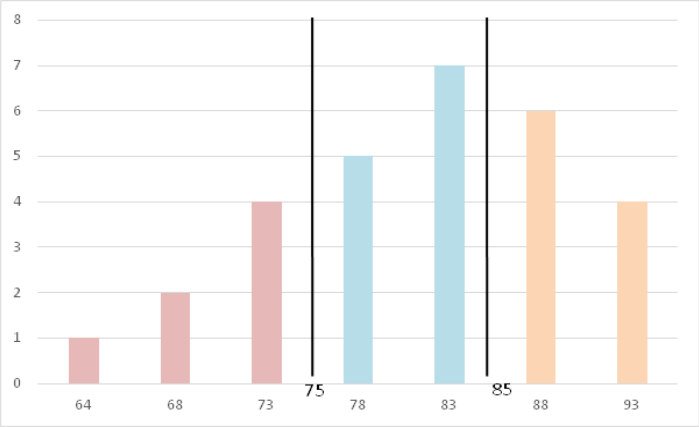

Figure 3: *Construction project planning course grade distribution*

3.1 Digital learning materials

Figure 4 shows the results of the learning performance questionnaire following the application of digital learning material in construction project planning, with the following notable results:

(1) As seen in Figure 4.1 the digital learning materials designed for the course had a high usage rate among participants. Figure 4.2 shows that academic performance increased with average weekly usage time.

(2) Figure 4.3 shows that half of students had their own internet access, thus reducing dependence on school equipment and increasing learning freedom and flexibility. It is worth noting that students primarily accessed the digital learning materials through desktop and notebook computers, or through smart phones, with smart phone users showing relatively higher learning performance. Figure 4.4 summarizes the survey results, showing that student learning habits have changed with the increased popularity of smart phone and that digital learning materials should increasingly be optimized for use on mobile devices.

(3) From teaching material use, the results in Figure 4.5 shows that students with better learning performance tend to rely more on the digital teaching material as a learning aid, while those with lower performance tend to use the teaching material to prepare for exams. Figure 4.6 shows that students see their digital learning materials as a means of making up for missed classes, and those with better learning performance also tend to rely on the digital learning materials as an integral part of regular study.

The above indicates that the participants showed a very high usage rate of the digital teaching material, and most students believed that they teaching material were helpful for learning. Those with better learning performance tended to use the teaching material as learning aids, while those who relied on them primarily to prepare for exams had relatively lower performance. More than half of all students had their own internet access, and smart phones were a leading means of accessing digital learning tools, with those using smart phones tending to outperform others. Therefore, future digital teaching materials should be optimized for use on smart phones.

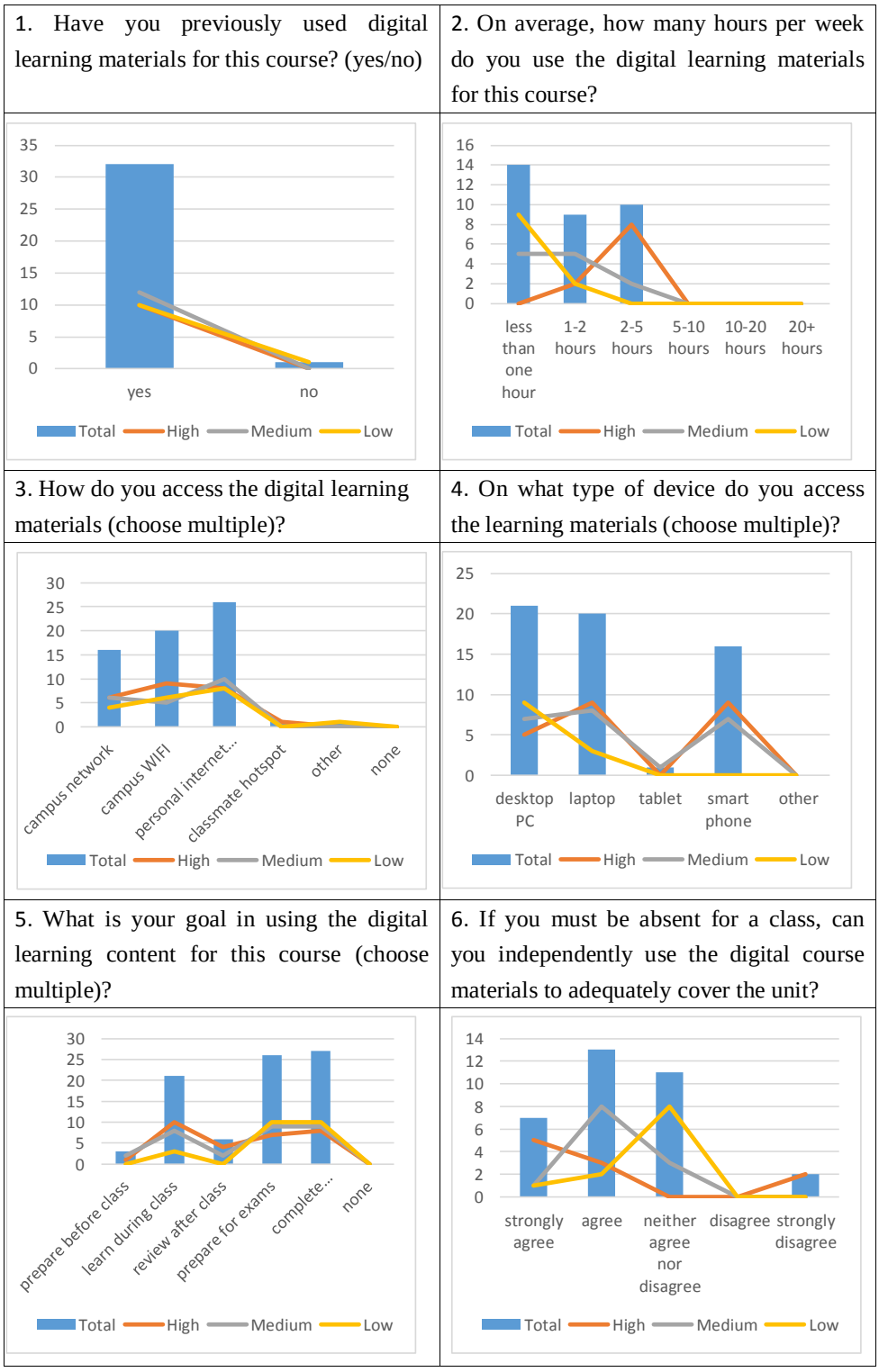

Figure 4: *Digital learning material application and learning performance*

3.2 Course Unit Operation

Figure 5 shows the result of the learning performance questionnaire following the use of coursework in the subject unit, with the following notable results:

(1) Figure 5.1 shows that students generally believe that the difficulty of the course content is manageable. Figure 5.2 shows that a high percentage of respondents agree that the coursework content helps them to grasp key points and improve overall learning efficiency.

(2) Figure 5.3 shows that most students believe that the coursework increases their ability and willingness to participate in discussion and their interest in the course material. In addition, Figure 5.4 shows that most students think that the coursework can help them better understand the learning content through independent inquiry, but this opinion was not reflected among students with relatively poor grades, and thus further study is required.

(3) Figure 5.5 shows that most students can complete the coursework within the required timeframe, and higher completeness correlates to better grades. Thus, learners with poor performance should be given additional time to complete assignments. In addition, Figure 5.6 shows that about 30% of students think that excessive assignments will hinder course progression, particularly students with relatively poor grades. This indicates that some students find the rigid course schedule to be a source of considerable stress. Thus, students should be provided with adequate time for study and counseling where appropriate.

The above shows that students have a high recognition of the learning benefits from the course unit assignments. Most students believe that the coursework can help them master key points, drive discussion, and enhance understanding and learning efficiency, thus effectively enhancing learner engagement and learning performance. However, about 30% of respondents (including most of the relatively poorly performing students) indicated that the workload was too heavy which reduced overall progress. This indicates that the coursework was a source of stress for some learners, suggesting the need to adjust unit assignments and progress expectations in the future design of teaching activities.

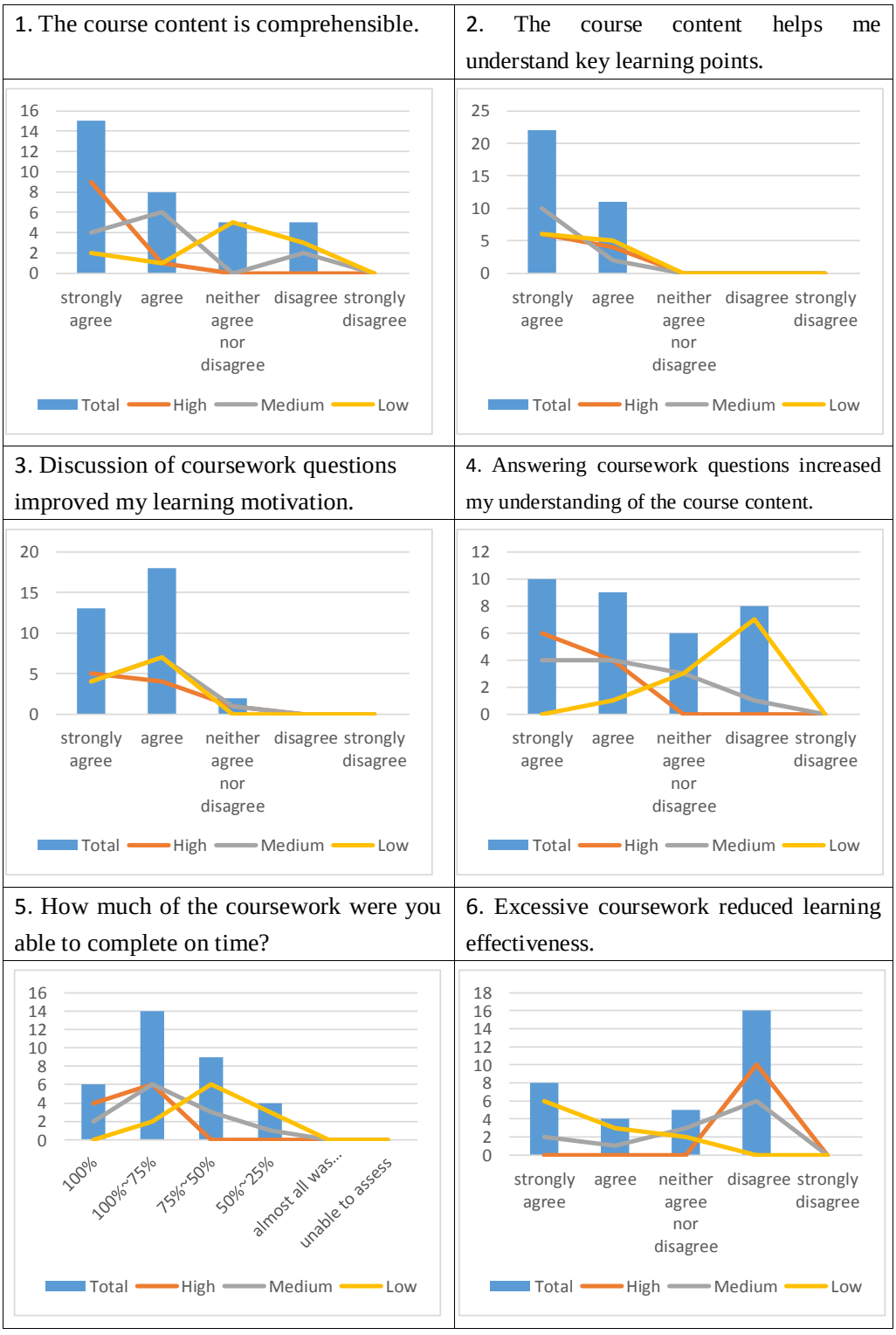

Figure 5: *Impact of coursework on learning outcomes*

3.3 Curriculum Activity Design

Figure 6 shows the results of the learning effectiveness questionnaire for the curriculum activity design in this subject, with the following notable results:

(1) Figure 6.1 shows that most students believe that the teaching methods designed for the course helped them achieve the learning objectives, and this belief was particularly apparent among learners with relatively higher performance. In addition, Figure 6.2 shows that students approach learning problems in two different ways, with some seeking solutions from discussion with classmates, while others relied more heavily on the digital course materials. This shows that the learning activities designed for the course could effectively be used by learners as a mechanism for problem solving.

(2) Figures 6.3 and 6.4 show that a very high percentage of participants, including both high and low performance learners, expressed satisfaction with course learning outcomes, including their understanding of practice techniques used in construction planning and management and the benefits of this knowledge in their future work.

(3) Figure 6.5 shows the relative perceived difficulty of the different learning modules, showing considerable difference among students at different performance levels. Better performing students had more difficulty with base line tracking and differentiation analysis, while lower performing students had more trouble with network schedule calculation and debugging. Mid-performing students found the combination of OBS with project activities to be particularly difficult. This is an unexpected and interesting finding, and the fact that students of different performance levels should have such clearly different perceptions of unit difficulty requires a more detailed investigation of student learning characteristics.

The above shows that most students believe that the teaching methods used in the course helped them achieve their learning goals, and most students relied heavily on the digital course materials to overcome learning challenges. In addition, it is worth noting that students with different performance levels perceived different learning modules as being particularly challenging. This phenomenon deserves additional study in terms of the impact of different learner characteristics.

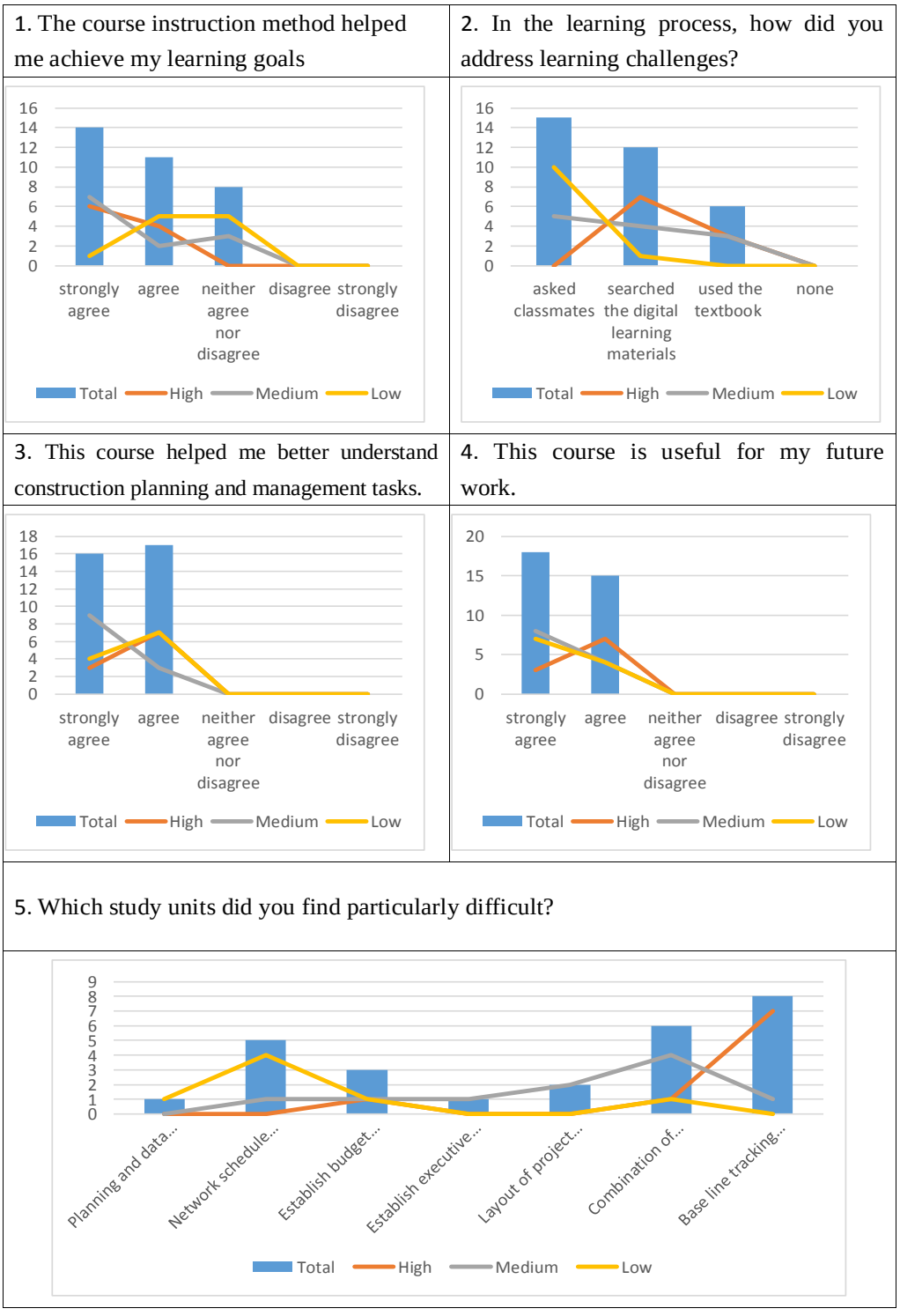

Figure 6: *Impact of curriculum design activity on learning outcome*

3.4 Overall learning effectiveness

This research describes the design of a series technique to improve learning effectiveness in the instruction of construction project planning. Following the semester-long course, a questionnaire was used to assess learning outcomes. Overall achievement is classified as being related to digital learning material, coursework operation and curriculum activity design.

Table 1: *Overall learning effectiveness*

Instructional Technique	Learning Effectiveness
Digital learning material	Digital learning materials had a high usage rate among students Digital learning materials helped students to overcome learning challenge. Digital learning materials can be accessed through smart phones, thus increasing learning flexibility. Using teaching material as learning aids helped students to improve learning performance.
Coursework operation	Coursework helps students to grasp learning key points. Coursework helps students to improve learning efficiency. Coursework increases students' willingness to participate in discussion. Coursework increases students' interest in the course material.
Curriculum activity design	Students were largely satisfied with the course learning outcomes. Teaching methods helped students achieve learning goals. Learning activities are effectively used by students as a mechanism for problem solving.

4. Conclusion

This study applied course unit operations and digital teaching materials to improve learning performance of civil engineering students in a construction project planning course. Following completion of the one-semester course, participants completed a questionnaire to assess perceptions, which were then analyzed in conjunction with learner performance on exams, revealing the following results:

- Digital teaching materials were found to have a high usage rate, and this usage rate was positively correlated with learner performance. High performance students used the digital teaching materials for homework and general learning, while those with relatively lower performance relied on the teaching materials primarily to prepare for exams, indicating that digital learning materials were used as the primary learning aid for the course.

- Learners, regardless of relative learning performance, all indicated that the modules enhanced their willingness to participate and engagement, thus enhancing learning outcomes. Moreover, degree of assignment completion was positively correlated to exam performance, but some students suggested that excessive coursework had a negative impact on learning progression.
- Students were highly satisfied with the course implementation and the practicality of the knowledge learned. Students relied significantly on the digital teaching materials and mutual assistance to address learning challenges, and the course learning activities were found to be conducive to promoting learning and mutual support and interaction, suggesting they can effectively help students solve problems and enhance learning outcomes.

This research successful develops an implementation strategy for improving learning effectiveness. However, this achievement is limited to the domain of construction project planning, and must be independently verified in other subject areas.

5. Scope for Future Work

Questionnaire results show students indicate a high degree of acceptance for and satisfaction with the digital teaching material and coursework. The adopted teaching strategy adopted successfully improved learning effectiveness. However, the investigation also raised some new issues including the following:

- Students tend to use smart phones to access digital teaching materials, raising the importance of optimizing such resources for display on smart phone interfaces.
- Students at different performance levels identified different modules as being particularly difficult and future work should examine the role played by learning characteristics in this phenomenon.
- About 30% of respondents felt that the coursework was excessive and hindered their progression, thus raising the need for increased time for study and counseling.

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