ISPRS Educational and Capacity Building Initiative 2022

A CHALLENGE-BASED LEARNING FRAMEWORK DESIGN AND PRACTICE FOR UAV PHOTOGRAMMETRY (CBL4UAV)

TECHNICAL REPORT

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ABSTRACT

The massive introduction of UAVs in our society has made these platforms and their data collection a very popular subject for education in a wide number of institutions (universities, life-long learning centres, applied sciences, etc.) all over the World. Experts in agriculture, urban planning, mining, and disaster management (just to give an example) are using UAV photogrammetry for data collection and information extraction: however, these professionals often operate without having any specific education in photogrammetry (and often without being aware of using it). Increasing the awareness of photogrammetry in these communities with some basic but essential concepts would be beneficial for its correct use. To be successful, these education modules would need to be embedded in an educational framework closer to their professional interests, different from traditional teaching methods.

The present study aims to develop a framework and provide guidelines for the integration of Challenge Based Learning into Geomatics education. This framework consists of three interconnected phases: engage, investigate, and act. Subsequently, an educational pilot program is created and implemented to apply the designed framework to key topics such as food security and cultural heritage. Finally, the project

refines the educational framework based on real pilot attempts and evaluation results, identifying potential issues and making necessary adjustments. The designed framework and the attained results are made publicly available for reference and utilization.

The developed framework, comprising forms, guidance documents, presentations, and tables, has been made openly accessible to anyone interested through the project's dedicated website: https://www.itc.nl/global-impact/itc-major-projects/!/cbl4uav

METHODOLOGY

The proposed methodology follows a general workflow consisting of five primary phases, as illustrated in Figure 1. The initial four phases are part of the framework development, where a versatile CBL-based educational framework is created. In the final phase, the framework is put into action, evaluated, and refined through a pilot implementation.

Engagement

In the engagement phase, the aim is to establish a connection between the students and the topic at hand. To achieve this, students are provided with the Big Idea and some initial guidance on transitioning from the Big Idea to Essential Questions. Throughout the Engage Phase, the focus shifts from a broad and conceptual Big Idea to a specific and actionable Challenge by employing the Essential Questioning process.

- Phase input: The Big Idea, engagement phase guideline, assessment rubric
- Phase output: challenge proposal

Investigate

The investigate phase focuses on the collaborative efforts of all participants to address the challenge, leveraging their individual knowledge and skills, and considering what they are expected to gain from the experience. It involves planning activities that lay the foundation for actionable and sustainable solutions. The phase begins with guiding questions aimed at identifying the additional knowledge required to analyze and resolve the challenge. This phase acts as a bridge, transitioning from the challenge identified in the engage phase to the practical activities undertaken in the subsequent phase.

- Phase input: Challenge proposal, investigate step guideline, assessment rubric
- Phase output: Investigate phase report

Act

In the final phase, evidence-based solutions are formulated and put into action, drawing upon the findings derived from the Engage and Investigate phases. The act phase involves evaluating the results obtained and integrating the students'

aspiration to make a meaningful impact or bring about innovation with their gained proficiency in understanding the big idea. This phase consists of three primary steps: solution concept, solution development, and implementation.

- Phase input: Challenge proposal, Investigation document, assessment rubric
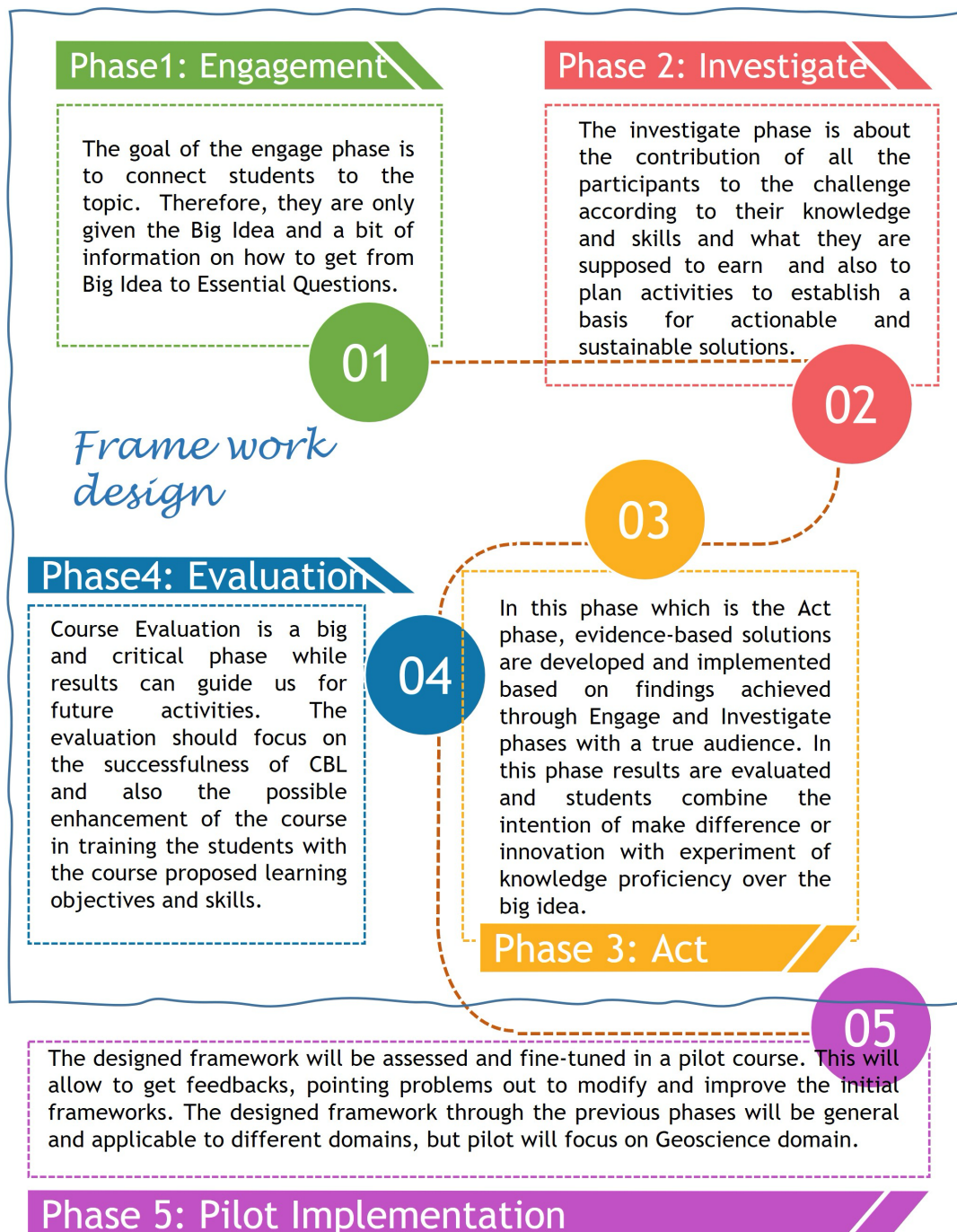- Phase output: Implementation and findings sharing

Phase1: Engagement

The goal of the engage phase is to connect students to the topic. Therefore, they are only given the Big Idea and a bit of information on how to get from Big Idea to Essential Questions.

01

Frame work design

Phase 2: Investigate

The investigate phase is about the contribution of all the participants to the challenge according to their knowledge and skills and what they are supposed to earn and also to plan activities to establish a basis for actionable and sustainable solutions.

02

03

Phase4: Evaluation

Course Evaluation is a big and critical phase while results can guide us for future activities. The evaluation should focus on the successfulness of CBL and also the possible enhancement of the course in training the students with the course proposed learning objectives and skills.

04

In this phase which is the Act phase, evidence-based solutions are developed and implemented based on findings achieved through Engage and Investigate phases with a true audience. In this phase results are evaluated and students combine the intention of make difference or innovation with experiment of knowledge proficiency over the big idea.

Phase 3: Act

05

The designed framework will be assessed and fine-tuned in a pilot course. This will allow to get feedbacks, pointing problems out to modify and improve the initial frameworks. The designed framework through the previous phases will be general and applicable to different domains, but pilot will focus on Geoscience domain.

Phase 5: Pilot Implementation

Fig. 1: Proposed CBL-framework strategy diagram.

Evaluation

The evaluation phase encompasses the assessment of not only the effectiveness of the newly designed CBL framework but also the accomplishments and contributions made throughout the project. As a result, the final evaluation strategy is developed during this phase, taking into account the following key elements:

- Evaluation of the new CBL framework using pre-designed questionnaires and via planning discussion sessions with all the people involved in the course.
- Evaluation of the whole course and comparing the results with those available from the previous years.
- For the evaluation, all the roles involved in the educational activities such as students, teachers, course coordinators, program coordinators, stakeholders, and supporting staff will be involved.

Pilot

To assess and evaluate the designed framework, pilot studies are required. In this particular phase, our focus is on UAV photogrammetry, an emerging technology with the ability to capture diverse geospatial data. Through the utilization of processing algorithms, the collected data can be analyzed, leading to the generation of valuable geospatial information. This information holds the potential to address various real-life multidisciplinary problems. However, many industrial and academic entities remain unaware of the potential benefits UAV photogrammetry offers in tackling their current challenges. Considering the flexibility, cost-effectiveness, wide availability, and capabilities of UAVs, they serve as practical and efficient platforms for data collection. Therefore, our study centers on UAV photogrammetry due to its significance.

RESULTS

The main purpose of this project is to design a framework based on CBL for teaching Geospatial concepts. For this purpose, five main phases are considered as discussed in the previous chapter. Here the experimental results are discussed.

For the first phase, the engagement document is designed. It has the intention of introducing the CBL concept to the students and motivating them on the advantages and added values of following such an educational framework. Then step by step guidelines are provided for them to follow. The main structure of the document is:

a) Introduction to challenge based Learning
b) Introduction to Big Idea
c) Introduction to Essential Question, Assignment 1: Essential Question
d) Introduction to Challenge Proposal, Assignment 2: challenge proposal
e) Assessment Rubric

The investigative document focuses on shaping the investigation activities of the students based on the main idea of CBL which is the importance of being involved with the real problem via actual stakeholders. The main structure of the designed document is composed of:

a) Introduction to guiding questions, factual and interpretative questions, Assignment 1: Guiding Questions
b) Introduction to guiding resources and activities, Assignment 2: Guiding resources and activities
c) Introduction to Analysis, Assignment 3: Analysis document
d) Introduction to Synthesis, Assignment 3: Synthesis document
e) Prepared forms for Guiding questions, activities, resources, analysis, and Synthesis
f) Assessment Rubric

For the Act phase, students are requested to carry out their projects. For this purpose, they first are requested to conceptualize their proposed solution considering their investigation and engagement activities. Based on that, they will develop the solution and finally implement it in a way to addresses all the raised concerns and topics. The structure here is:

a) Introduction to Act phase; solution concept, solution development, solution implementation
b) Assignment: Act presentation

The evaluation phase is an integral part of this framework and is implemented during the pilot phase. The evaluation process primarily focuses on identifying the strengths and limitations of CBL, as well as encouraging students to reflect on their learning experiences through CBL. Specific questions are provided to assist students in comparing the CBL framework with their previous experiences in traditional knowledge-transferring educational settings. The evaluation phase aims to assess the added value of CBL and gather valuable insights from students' perspectives.

Moreover, evaluation is also needed to measure and weigh experimenting with CBL from an educator's point of view. Teachers, instructors, tutors, and stakeholders also experience different journeys of education where the feedback can help to improve the course and address the limitations. The main elements of this section are:

a) Evaluation form for the students
b) Evaluation form for the staff

The designed framework is implemented for educational purposes in two master courses, one at the University of Twente and the other at the University of Tehran. The primary objective is to apply the framework and make necessary modifications based on the lessons learned during the experimental phase. The mentoring team consists of a teacher, a local supervisor, and stakeholders. The teacher possesses experience in CBL, having participated in a pilot program while implementing her UTQ (University Teaching Qualification).

The pilot selected course A: For the implementation of the designed framework, a course that is embedded in MGEO master program in ITC faculty, University of Twente is selected. In this two-year Master's program taught in English, students will be equipped with the necessary skills to tackle a wide range of global challenges.

These challenges include climate change, resource depletion, and pandemic diseases, which impact our society and vulnerable populations worldwide. Through the use of geo-information systems, students will learn how to effectively address these issues.

The pilot selected course B: In the second pilot, jointly with the University of Tehran the designed CBL framework is tested for master students of Conservation of Cultural Property under the topic of UAV Photogrammetry for cultural monitoring.

Recognizing the demand for architects who possess expertise in both research and practice and acknowledging the aspirations of numerous architecture graduates to pursue further education in postgraduate and Ph.D. programs, the University of Tehran, the oldest university in Iran, initiated its part-time Master's program in 2002. This program admits approximately twenty students annually. In order to enhance the quality of architectural education, the program offers diverse design studios, each focusing on a specific theme. The Interior Architecture program was the first to be introduced in 2010, with an annual intake of around fifteen students.

SUMMARY

This project aims at the framework development for conducting educational activities based on adopting Challenge-Based Learning and developing that for master course implementation in Geomatics Engineering. The framework is designed and it is openly published and accessible through the project web page. Some key findings from the executed pilots can be summarized:

- Students mostly found the CBL practice more time-consuming than their previous normal knowledge-transferring experiences
- Students believe more effort is needed to handle CBL and more team working involvement is desired
- They found CBL more promising in providing them with the practical knowledge and skills they are supposed to learn after attending the theoretical part of the course
- Students at these course pilots mostly prefer CBL to the normal education
- Students find CBL less successful in course content knowledge provision
- Staff find the assessment part of the CBL the most challenging issue
- Staff find their role at CBL more supervisory than normal education
- Staff believe CBL is more successful than normal education for the practical part of the courses and they are not sure if it can be a good replacement for knowledge transferring in traditional education

Assessing students in CBL educational courses can be a challenging task, particularly when it comes to grading. On one hand, we need to evaluate students based on the established learning objectives of the course, which is similar to conventional assessment practices. However, on the other hand, the active involvement of students in the challenges presented in CBL requires additional assessment considerations. This is because participating in these challenges demands significant time, effort, and energy from the students. As a result, there is a

need to place greater emphasis on developing assessment protocols for future studies in order to address these unique aspects of CBL.

APPENDIX

DISSEMINATION

The educational Initiative has been largely advertised during some events held in 2022 and 2023. One paper was presented at the SEFI conference 2023 (September 2023, Dublin, Ireland). We also discussed and shared the project, implementation results, and findings with our colleagues at the University who are focusing on CBL and our educational experts in the Centre of Expertise in Learning and Teaching. The developed framework, comprising forms, guidance documents, presentations, and tables, has been made openly accessible to anyone interested through the project's dedicated website: https://www.itc.nl/global-impact/itc-major-projects/!/cbl4uav.