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Exploring the Possibility of Harnessing Drones in Geography Education in High Schools

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Abstract: This working paper discusses our initiative to explore the possibility of harnessing drones as an inquiry-based learning tool in geography education for supporting outdoor fieldwork. In particular, we focus on delineating (i) the rationale behind this initiative, and (ii) the direction of how to adopt drones in geography learning and teaching based on the high-school context in Hong Kong.

Keywords: Drones, drone-assisted learning (DAL), inquiry-based learning, geography education, outdoor fieldwork, high schools

1. Drone-Assisted Learning (DAL)

Drone-assisted learning (DAL) has been regarded as one of the potential technology-enhanced learning approaches to be widely adopted in the field of education (Shadiev et al., 2022). Nonetheless, in K-12 contexts, most empirical studies and representative examples of DAL so far are mainly pertaining to STEM education or STEM-related subjects, in particular, with the purpose of supporting the learning and teaching activities of computational thinking, computer literacy and programming skills (e.g., Bhuyan et al., 2020; Breuch et al., 2020; Chou, 2018; Fokides et al., 2017). There has been a lack of DAL research on exploring the possibility of leveraging drones to support high-school students in conducting outdoor inquiry-based fieldwork in geography education.

2. High-School Geography Curriculum in Hong Kong

In alignment with the educational reform for promoting student-centredness in school education in Hong Kong, the revamped statutory high-school geography curriculum lays strong emphasis on theme-based and inquiry-based learning (Curriculum Development Council, 2022; Jong, 2023; Jong et al., 2019; 2020a; 2020b). In the curriculum, each geographical theme involves a number of curricular topics; the content of each topic pivots around a central inquiry question. Figure 1 illustrates an example of a curricular topic and inquiry question under the geographical theme of “Dynamic Earth.”

3. Proposed Pedagogical Use of Drones in Outdoor Inquiry-Based Fieldwork

In Hong Kong, typically, a high-school geography teacher uses a 15-day teaching cycle to cover a curricular topic (see Figure 1), in which five lessons (70 minutes each) are evenly distributed in each cycle. Based on this learning and teaching context, we have proposed a pedagogy for facilitating students to harness drones to conduct outdoor inquiry-based

fieldwork. The design of this pedagogy is theoretically grounded on Pedaste et al.'s (2015) five-stage inquiry-based learning model, namely *Communication*, *Engagement*, *Exploration*, *Expression* and *Evaluation*. Figure 2 illustrates the implementation of this pedagogy within a 15-day teaching cycle.

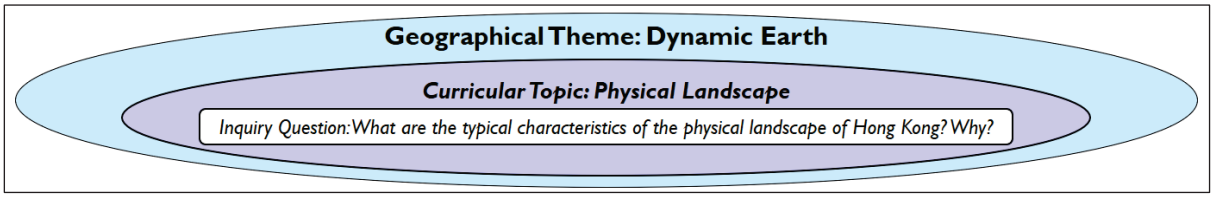

Figure 1. A curricular topic and inquiry question under a geographical theme.

Days	Description (T: Teacher; Ss: Students)
Days 1–3	• **Day 1 (in-lesson communication):** T connects Ss to the topic's background, introduce them to drones as an aerial observational data collection tool, and discuss with them the ethical/ safety issues and technical restrictions of drones with respect to the regulation in Hong Kong. • **Days 2–3 (off-lesson engagement):** Ss (i) access short video materials posted by T on the LMS to gain a more comprehensive picture of the topic's background and deepen their understanding of ethical/ safety issues and technical restrictions of drones, and (ii) conduct beginning "virtual" practice on the operation of the drone to be used later by experimenting with the corresponding flying simulation application.
Days 4–6	• **Day 4 (in-lesson communication):** T recaps the important points underpinned to the videos that Ss have watched in Days 2–3. After that, T demonstrates how to operate the drone and make use of its photo- and video-capturing functions to collect aerial observational data. Then, Ss are divided into groups. Each group is given a drone to get real hands-on practice. • **Days 5–6 (off-lesson engagement):** Ss continue to use the simulation application for conducting some advanced "virtual" practice on drone flying and aerial observational data collection.
Days 7–9	• **Day 7 (in-lesson communication):** T discusses the topic's core inquiry question with Ss, equips them with the related key geological and geomorphological concepts, and guides them to break down the core question into a number of sub-questions in terms of the concepts. • **Days 8–9 (off-lesson exploration):** T leads Ss to the fieldwork site to conduct the aerial inquiry-based outdoor fieldwork. The sub-questions formulated on Day 7 will scaffold each group to probe into the phenomena by collecting useful aerial observational data through photo- and video-capturing. All groups' inquiry proceedings are recorded in their drones.
Days 10–12	• **Day 10 (in-lesson communication):** Each group discusses the data collected in the fieldwork and co-constructs explanatory answers for responding to the sub-questions. During the discussion, they can access the inquiry proceedings from the provided tablets to support and triangulate their answers. • **Days 11–12 (off-lesson expression):** Each group prepares a presentation (with a visual aid) to elaborate and explain their findings (answers) to all the sub-questions with the arguments collectively developed on Day 10.
Days 13–15	• **Day 13 (in-lesson communication):** Each group gives the presentation and receives feedback from other groups. After that, T debriefs the class on (i) the strengths/ weaknesses of their findings, (ii) what knowledge they have learned and how the knowledge can be used when studying other topics, and (iii) the importance of observing the ethical and safety measures when conducting drone-aimed outdoor fieldwork. • **Days 14–15 (off-lesson evaluation):** Each group reflects on their previous "answers" to the sub-questions based on the new insights obtained on Day 13, updates their presentation file with the refined answers and ethical/ safety reflection on using the drone as a learning tool, and finally uploads it to the LMS for other groups' reference.

Figure 2. Harnessing drones in outdoor inquiry-based fieldwork.

4. Conclusion and Future Research

Drones have been foreseen as a potential tool to be widely adopted for supporting K-16 learning and teaching (Shadiev et al., 2022). Inquiry-based learning has been regarded as an important instructional approach to facilitating constructivist, student-centred education and training (Huang et al., 2022; Pedaste et al., 2015). This working paper presents our initiative to develop a DAL pedagogy for supporting outdoor inquiry-based fieldwork in the context of Hong Kong high-school geography education. A critical piece of our coming work is to conduct empirical research to evaluate the effectiveness of this pedagogy. Moreover, it is important to collaborate with frontline geography teachers to enact design-based research (DBR) (Jong et al. 2023; Mckenney et al., 2019) for optimising the design and implementation of this pedagogy so that it can be pragmatically adopted in different school settings in the circumstance of formal education.

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