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# ARE DISASTER-PRONE COUNTRIES' UNDERGRADUATE STUDENTS PREPARED? INSIGHTS FROM A CIVIL ENGINEERING PROGRAM IN NEPAL

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***Keywords**: Disaster Risk Reduction, resilience competencies, engineering education, disaster-prone countries*

## ABSTRACT

The increasing magnitude and frequency of disasters require civil engineers to possess the ability to understand disaster risk and design resilient infrastructures. However, it remains unclear whether undergraduate civil engineering students in disaster-prone countries like Nepal are adequately prepared to meet this demand. In this study, we conducted a case study using a questionnaire among undergraduate civil engineering students (n = 127) from a Nepalese university to evaluate their knowledge of Disaster Risk Reduction (DRR), resilience concepts, and related competencies. Our findings indicate that social media and social networks are the primary sources of DRR knowledge and information for these students. Nearly half of

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the students expressed neutral perceptions of the local disaster risk. While students exhibited DRR knowledge, they had limited opportunities to participate in DRR courses, workshops, or training. Students possess the basic concepts of resilience, but there was a notable gap in their ability to apply these concepts in designing resilient structures. This suggests that additional efforts are necessary to integrate these competencies into engineering curricula. Our findings provide insights to educators, curriculum designers, and policymakers in recognizing the need to transform the teaching-learning pedagogy within engineering education. Future studies are recommended to identify the underlying causes hindering the development of resilience competencies through qualitative interviews and performance-based assessments.

## 1 INTRODUCTION

Given the growing occurrence and severity of natural disasters driven by climate change, conflicts, and socio-economic changes, engineers play a critical role in developing systems and infrastructures capable of withstanding and adapting to disruption (Diwekar et al., 2021; Martin et al., 2022). Mainstreaming Disaster Risk Reduction (DRR) in education has been recognized as a key approach to mitigating disaster impacts, particularly in countries highly vulnerable to natural hazards (Baytiyeh, 2018) and is emphasized in global frameworks such as the United Nations Sendai Framework for Disaster Risk Reduction (UNDRR, 2015).

Civil engineering, in particular, is central to this effort due to its direct involvement in designing, constructing, and maintaining resilient infrastructure (Kolathayar et al., 2022). However, research indicates that universities focus on traditional and technical skills and lack sufficient integration of DRR competencies in civil engineering curricula in disaster-prone countries (Gutierrez-Bucheli et al., 2023). This limits the students' ability to tackle the current global challenges posed by disasters. Since undergraduate students may not pursue further studies or may opt for education abroad (Trital et al., 2023), it is critical to investigate whether undergraduate programs provide adequate preparation for the competencies needed to mitigate disaster risk.

## 2 THEORETICAL BACKGROUND

### 2.1 Need for disaster risk reduction education in disaster-prone countries

The main aim of DRR is preventing new disasters and reduce existing disaster risks to strengthen resilience and mitigate the current risk (UNDRR, 2017b). SFDRR highlights the significance of educational facilities and the inclusion of DRR in curricula at different levels (Sakurai & Sato, 2016). To achieve the targets of SFDRR and reduce disaster risk, communities need to be aware of disaster risk and resilient construction, which should start by integrating these concepts into all levels of education. DRR in education involves a systematic approach that incorporates disaster risk analysis and risk reduction measures in the educational sector.

Nepal is a hotspot for environmental disasters such as earthquakes, floods, landslides, and heat and cold waves due to topography, active tectonics, and weak governance. Moreover, Nepal ranks 69$^{th}$ in terms of extreme weather impacts in the climate risk index for 2022 (Adil et al., 2025). Given the increasing disaster risk, DRR in education is considered a priority area by Nepal’s Disaster Risk Reduction National Strategic Plan of Action (2018-2030), following the SFDRR targets (MOHA, 2018). This

suggests the need for curricular reformation in engineering education. However, research shows that disaster awareness and preparedness education are still lacking in many developing countries of Asia (Nipa et al., 2020; Pant et al., 2020).

In the Nepalese context, several factors hinder an adequate curricular integration of DRR and related competencies. Especially, the rigid academic structures hamper the adoption of new content and approaches (Pant et al., 2020). Additionally, a primary focus on the response and recovery phases of the disaster risk management cycle (Lamichhane, 2018), as well as limited opportunities for industry-academia partnerships, which enable real-world learning (Pant et al., 2020) are among the key limiting factors. Many of these challenges reflect broader structural issues in Nepal's higher education system, where engineering programs often face inadequate resources, uneven faculty capacity, limited pedagogical innovation, and bureaucratic and politicized academic governance that hinders curriculum reform and quality assurance processes (Dhamala et al., 2021; Joshi & Joshi, 2015). Since insufficient DRR in education limits the communities' capacity to prepare and respond to disasters (Petal, 2008), it increases their vulnerability and thus the severity of disaster impacts. Thus, it is pivotal to evaluate how well current educational programs effectively prepare engineers to respond to disasters.

### 2.2 Competencies needed for disaster risk reduction

Civil engineers require an understanding of disaster risk-related knowledge, as explained in UNDRR (2021) to participate in DRR efforts and reduce potential disaster impacts effectively. Since different regions face different types of disasters, the students must possess sufficient knowledge to understand the complexities of the various disaster types, analyze their potential risk, and prepare themselves to effectively respond to such events (Gilbert, 2008). Furthermore, civil engineers should be adept at enhancing the system's ability to adapt and recover timely and efficient manner from the effects of hazards, commonly referred to as the resilience concept (UNDRR, 2017a). These capabilities enable students to develop risk-based thinking, strategies for designing, evaluating, and maintaining structural resilience, preparedness for response and recovery, and raise awareness among individuals for applying the concepts of DRR during disasters (Olores et al., 2023; Prokofieva et al., 2018; Tuladhar et al., 2014). Previous studies suggest that students might have a limited understanding of DRR-related knowledge, which can hinder their ability to manage disasters (Cabuga Jr et al., 2023; Tuladhar et al., 2014).

Beyond DRR knowledge, resilience competencies are increasingly vital for engineering students to mitigate disaster impacts (Martin et al., 2022) - perhaps even more for those who will build their careers in disaster-prone areas. Given the increased frequency and severity of disasters, engineers are not only tasked with designing structures that withstand shocks but also with developing adaptive solutions that enable communities to recover and thrive in the face of ongoing uncertainty (Folke et al., 2010; Walker, 2020). These abilities - referred to as resilience-related competencies - can be understood as the capacity to anticipate, absorb, adapt to, and recover from disruptions while learning from past crises to build long-term resilience (Francis & Bekera, 2014; Winkens & Leicht-Scholten, 2023). These competencies emphasize the recognition of the limits of prediction and the likelihood of unforeseen threats, and therefore are proactive in nature (Levin et al., 2022; Seager et al., 2012).

Within engineering education, resilience competencies include abilities such as systems thinking, the ability to navigate complexity and uncertainty, and interdisciplinary collaboration (Pearson et al., 2018; Winkens & Leicht-Scholten, 2021). Despite the recognition of their importance, research suggests that these competencies remain underdeveloped in many engineering curricula, including the European context (Perdikou et al., 2016; Winkens & Leicht-Scholten, 2023). Despite Nepal's high exposure to multiple hazards, these competencies have not been directly studied. As a result, the development of resilient engineering solutions that can withstand increasing uncertainty is hindered (National Planning Commission, 2015). To address the gap, there is a need for exemplary cases that demonstrate how DRR knowledge and resilience competencies can be integrated into engineering education in a context-sensitive way to inform scalable and locally relevant curricular innovations.

Ensuring that education supports engineering students to develop both DRR knowledge and resilience competencies is crucial for preparing graduates for the challenges they will face, particularly in disaster-prone areas. Yet, little research has examined how undergraduate engineering students, in these regions, perceive and acquire both DRR knowledge and resilience competencies. Our study addresses this gap through the following research questions (RQ):

> **RQ1:** How do undergraduate civil engineering students in disaster-prone countries develop disaster risk reduction knowledge?
> **RQ2:** How do undergraduate civil engineering students in disaster-prone countries perceive their own disaster risk reduction knowledge and resilience competencies?

## 3 METHODOLOGY

By using undergraduate civil engineering education in Nepal as a case study, our study employed a quantitative research design to address the two research questions defined above.

### 3.1 Data collection strategy and participants

We collected our data using an online survey that was structured into four sections i) demographic information, ii) students' experiences with disasters and how they have developed knowledge in this area, iii) their perceptions of their disaster risk knowledge (denoted as eleven K variables), and iv) perceptions of their personal resilience competencies (denoted as thirteen R variables). The third and fourth sections utilized a five-point Likert scale (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly agree) to capture students' self-assessments. The statements in the third section were adapted from Tuladhar et al.'s (2014) framework on knowledge, risk perception, and awareness in disaster risk reduction education. The fourth section was adapted from Winkens & Leicht-Scholten's (2023) framework of resilience-related competencies in engineering education. To ensure relevance for the specific context of civil engineering education, we elaborated both disaster risk knowledge and competencies into context-specific statements for the third and fourth sections of the survey. The questionnaire was evaluated and approved by Aalto University's ethics committee before the data collection.

Our study targeted undergraduate civil engineering students in a Nepalese engineering college. We used stratified sampling to survey students across four academic cohorts to ensure representation of different stages of education. The

survey was administered during scheduled class sessions, where researchers visited classrooms and invited students to respond online using their own devices. Additionally, a web link was provided to students when visiting the classrooms was not possible. Overall, 127 students participated, representing 59% of the total enrolled students across the four cohorts. The sample included 33 first-year students, 40 second-year students, 30 third-year students, and 24 fourth-year students, each of which included at least 50% of students in the respective cohort. Two-thirds of the respondents were male, and the range of ages of the respondents was from 16 to 24 years.

The home addresses of respondents were spatially distributed across all seven provinces of Nepal. Earthquake was the most commonly experienced disaster (85%), followed by floods and landslides (40%). While more than 50% of the students had experienced more than one disaster in the past, the actual number ranged from one to more than 10. 33% of the third and fourth-year students were planning to work in the field and industry, while 56% of them replied that they hope to simultaneously work in the field and continue their education by attending a master's program.

### 3.2 Data Analysis

We conducted descriptive analysis (e.g., arithmetic mean) of the students' disaster experience, knowledge, and risk perception, DRR information sources, and resilience concept. Additionally, we visualized the data as a spider plot using the mean value of resilience competencies for each cohort of students based on the academic year. All analyses were performed using Python.

### 3.3 Limitations

Our empirical data relies on students' self-assessments, which may introduce biases and not reflect the actual level of their knowledge and competencies. Furthermore, social desirability bias may influence students' responses since the students might respond in a way that is perceived favourably by others rather than truthfully, resulting in over- or underreporting (Kwak et al., 2021). Future studies could incorporate objective assessments or triangulate self-reported data with performance-based measures to analyse social desirability bias and enhance validity.

## 4 RESULTS

### 4.1 Sources of DRR knowledge among students

Undergraduate civil engineering students acquired DRR-related knowledge from various sources and with varying frequency (Fig. 1). Importantly, 90% of students responded, "very often" and "often" for social media, indicating social media as the main/primary channel for knowledge compared to traditional channels like newspapers and television. Similar responses (65%) were seen for receiving DRR-related information from friends and families, making it the second most-reported source for information. This result suggests that informal social networks are significant for understanding disaster risk knowledge. In contrast, a higher proportion of "Never" and "Rarely" responses for governmental channels and newspapers suggests that the information from these channels might not be reaching the students effectively, or they don't consider these sources reliable or accessible. In addition to these general information sources for DRR-related knowledge, only 5% of the second, third, and fourth-year students responded that they had participated in such courses

or training in the past. This result highlights the limited integration of DRR within academic curricula across different educational levels.

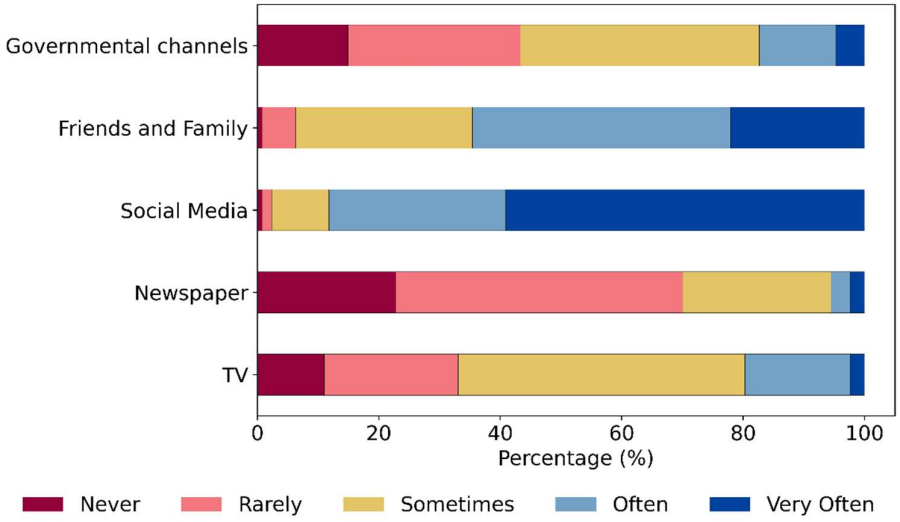


*Fig. 1. Respondents' (n=127) reported usage of various information sources for accessing DRR-related information.*

### 4.2 Students' disaster risk perception, disaster knowledge, and basic resilience concept

Our data demonstrates that students are aware of disasters, the risk they pose, and the basic concept of resilience (Fig. 2A). Almost 60% of respondents agreed or strongly agreed that they had disaster-related knowledge (average over K3–K8 in Fig. 2A). Half of the students were neutral about the disaster risk in their area (K1), however, they had a good understanding of the risk posed by disasters in the engineering sector (K2). Additionally, the understanding of the basic resilience concept was found to increase with the progression of the academic year, suggesting that the resilience concept is progressively integrated into the university curriculum (Fig. 2B).

### 4.3 Resilience competencies among students

When studying the 13 key resilience competencies and their variation among undergraduate students across four academic years, the average score for resilience competencies clusters between neutral and agree, independent of their stage of studies (Fig. 2C). Risk governance and adaptive competencies such as absorption, responding, transformation, learning from failure, and recognition of threats (R3, R6, R7, R8, and R9) indicate clear advancement from first to fourth-year students. A similar trend was observed for the foundational resilience competencies, such as the ability to deal with complexity and the ability to retain system identity (R11 and R13). The fourth-year students stood out in terms of their ability to anticipate (R1).

Interestingly, competencies of preparedness and response (R4 and R5), and cognitive competencies such as the ability to deal with uncertainty and develop with change (R10 and R12) were highest for third-year students. In general, though fourth-year students had slightly higher scores in most competencies than the other years, the average score seems to be slightly above neutral. This indicates that additional efforts are required to incorporate these competencies, particularly towards the final year of

their studies, to ensure students are equipped to design, evaluate, and monitor the resilient infrastructure upon completing their course.

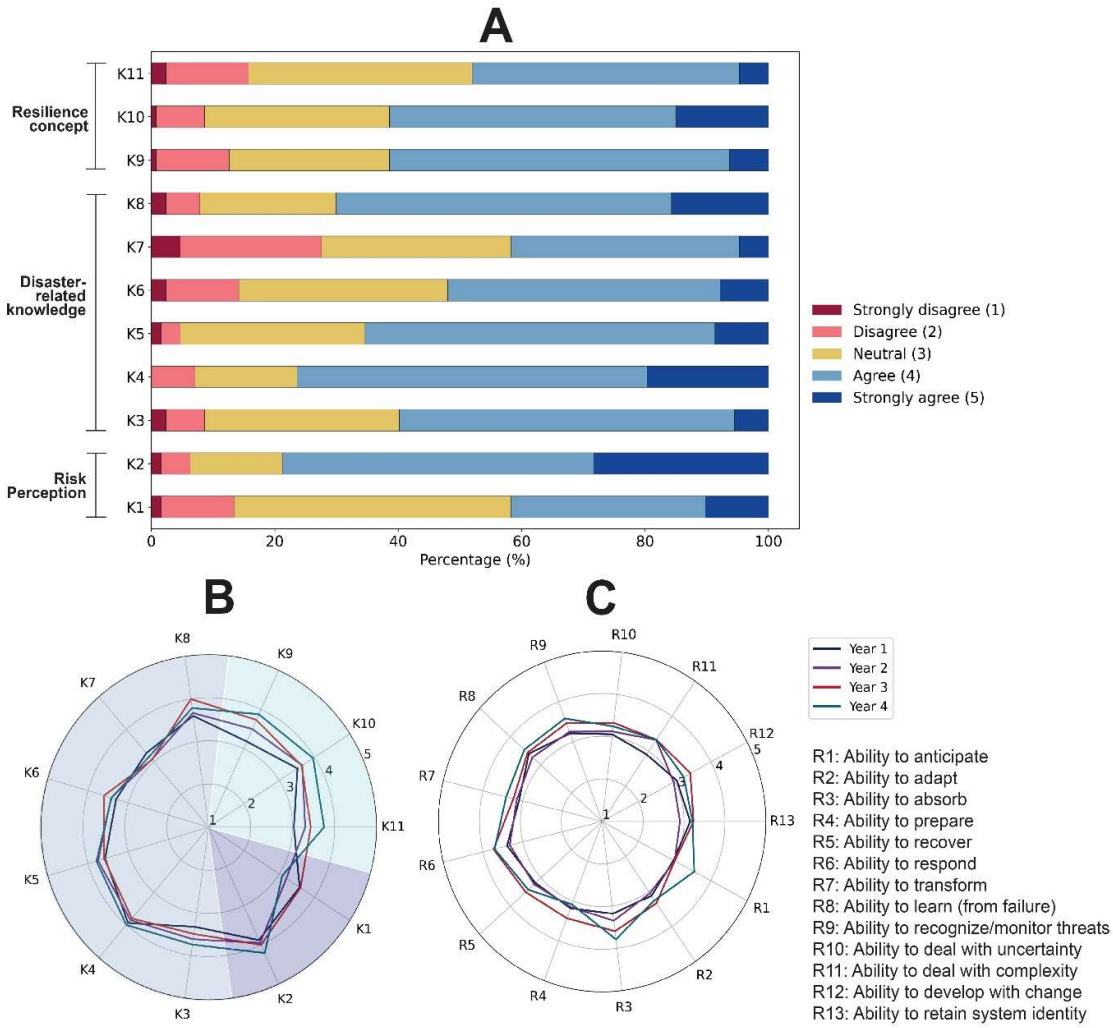


*Fig. 2. A) Reported risk perception, knowledge, and resilience concept among respondents (n=127); B) Distribution of risk perception, knowledge, and resilience concept by academic year; C) Distribution of resilience competencies by academic year. The same Likert scale is used in all illustrations.*

## 5 DISCUSSION

Our study assesses DRR knowledge and resilience competencies among undergraduate civil engineering students in Nepal. Employing the framework by Winkens & Leicht-Scholten (2023), this study advances previous studies focused on disaster knowledge, attitude, preparedness, and risk perception (Calamba, 2024; Olores et al., 2023; Tuladhar et al., 2014) by explicitly examining the resilience competencies. As civil engineers are at the forefront of infrastructure design and construction, assessing the knowledge and competencies among undergraduate civil engineering students is crucial. Our study has three key contributions and implications for future research and practice.

Firstly, students primarily rely on social media and social networks for DRR-related information over traditional sources such as newspapers and television, which might impact the reliability of DRR communication (Bui, 2019). While platforms such as Facebook and TikTok offer valuable information, there is a risk of communicating inaccurate information. By strategically utilizing the digital platforms and fostering the collaboration between universities and disaster management agencies, reliable DRR communication can be ensured (Chang, 2024; Sjoraida & Anwar, 2018; Skinner & Rampersad, 2014). Future research could focus on integrating media literacy into curricula and assessing students' critical thinking capabilities to evaluate the accuracy of DRR information on online platforms.

Secondly, while students demonstrate strong disaster-related knowledge and basic resilience concepts, they are uncertain about the local disaster risks, possibly due to fading memories of personal experiences (Sutton et al., 2020; Wiwik Astuti et al., 2021). Thus, continuous integration of hands-on experiences through experiential learning, such as problem-based learning (PBL) and simulation-based learning, can reinforce DRR knowledge (López et al., 2023; Murray et al., 2019; Yasaroh et al., 2023). Additionally, exploring multistakeholder initiatives, such as global PBL (Jurelionis et al., 2023), can help students deepen their understanding of disaster preparedness by exposing them to diverse local contexts, interdisciplinary risk perceptions, and response strategies.

Finally, our findings indicate that, despite students' perception of possessing resilience competencies, these competencies are not fully developed. Given that the Nepal government is attempting to integrate DRR in education, additional efforts are necessary to improve students' confidence to tackle challenges posed by disasters. Here, for example, improving interdisciplinary practices through case studies, hands-on learning, real-world disaster scenarios, and integrating local perspectives for building resilient communities holds vast potential (López et al., 2023; Pant et al., 2020; Pushnik & Hatfield, 2016; Shrestha et al., 2025). Future studies are recommended to identify the underlying causes hindering the development of resilience competencies through qualitative interviews and performance-based assessments.

In conclusion, this study highlights the existing level of DRR knowledge and resilience competencies among undergraduate civil engineering students. The findings provide insights for universities, teachers, and educators to evaluate the need for curricular reformation and transformation in teaching learning pedagogy to advance students' competencies for mitigating disaster risk. We recommend conducting cross-country studies in disaster-prone areas to compare students' proficiency and share best practices. Insights from this research can also guide capacity-building projects by the European Union to support low and middle-income nations, such as Nepal, in disaster contexts.

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