Review

Applications of Photovoice-Based Entrepreneurial-Minded Pedagogical Interventions in the Engineering Classroom

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Abstract: The recent emergence of generative AI technologies is beginning to shape workforce hiring practices. The shift towards skills-based hiring over degree-based hiring has sparked concerns over the ability of college graduates to be prepared for their career roles. One approach to equip students to work with technology and adapt to rapidly changing environments is the development of an entrepreneurial mindset. One way to cultivate entrepreneurial thinking is through the participatory action research methodology, photovoice. This study explores how photovoice promotes discovery, evaluation, and exploitation of opportunities in university engineering classrooms. For this study, a literature review was conducted to identify, evaluate, and interpret available research. For the review, a five-step process was used. This process included defining a search criterion, constructing a Boolean logic search query, inserting the query into multiple academic search engines/databases, screening and selecting articles, and categorizing and mapping the literature. The review's findings were organized based on the type of study, participants, duration of study and photovoice interventions used, study outcomes, and entrepreneurial mindset development. The results discussed in this paper offer insights, guidance, recommendations, and future directions for engineering education research.

Keywords: photovoice; undergraduate; engineering; entrepreneurial mindset; innovation; continuous improvement; pedagogical intervention

1. Introduction

Technology is a key driver of economic growth and competition worldwide. However, workplace and educational technology is constantly changing, and higher education instructors are struggling to keep up. For example, the recent proliferation of integrating generative AI in classrooms has sparked a paradigm shift in teaching and learning [1–5]. The rapid emergence of generative AI is beginning to reshape hiring plans, employee productivity, and job requirements, indicating a shift towards skills-based hiring over degree-based hiring. This technological shift has caused college graduates to question how prepared they are for today's workforce [6–9]. With new technologies, educators and higher education institutions should consider providing more support and guidance to prepare students for such technological shifts.

One approach to better prepare students for working with technology and rapidly changing environments is the development of an entrepreneurial mindset. The entrepreneurial mindset is defined as the inclination to discover, evaluate, and exploit opportunities [10,11]. Cultivating entrepreneurial thinking or traits is essential for all students, regardless of their disciplinary backgrounds or careers, and having an entrepreneurial mindset offers several benefits [12–16]. First, the entrepreneurial mindset can be leveraged to start a new business venture (e.g., recognizing the motivation to start a company). Second, the entrepreneurial mindset can be applied in a job role to solve problems, think critically, adapt to a fast-paced work environment, and be productive. Third, the entrepreneurial mindset can be leveraged to address global and societal challenges such as the United

Nations Sustainable Development Goals and the National Academies of Engineering Grand Challenges. Fourth, the entrepreneurial mindset can be applied for self-improvement, such as cultivating habits, setting goals, and learning new skills.

One way to develop an entrepreneurial mindset is through the participatory action research methodology, photovoice. Photovoice, commonly associated with participatory action research (PAR), is a visual method that is used to understand how people perceive the world around them. According to Wang and Burris [17], photovoice is an innovative participatory tool that enables people to "identify, represent, and enhance their community" through the use of photos and narrative reflections. The photovoice process involves researchers actively engaging the participants of a study in the research and inquiry process to collect data, reflect, and gather new perspectives on making improvements [17–20]. The photovoice research method has been used to promote student engagement in class-rooms, encourage discussion, stimulate dialogue amongst the oppressed and privileged populations, and as a needs assessment, pedagogical, and evaluation tool [21–29].

Photovoice has been widely used as a research approach to problem solving through the use of photos/images and narrative reflections [30–32]. As any research process involves purpose, the photovoice method also has three primary goals: (1) provide a creative way for individuals to reflect on existing problems and analyze their strengths and weaknesses, (2) engage individuals in critical dialogue and discussion, and (3) develop and execute an action plan to drive social change [17]. Although photovoice has been used in engineering classrooms to examine student experiences (e.g., mental health challenges, first-year experiences, motivations, and barriers) [33–39], photovoice interventions to cultivate entrepreneurial thinking are limited and warrant further examination.

To explore how photovoice is being used to promote the entrepreneurial mindset in undergraduate engineering classrooms, the study aims to conduct a literature review to identify, evaluate, and interpret available research relevant to our research question [40–43]. For the literature review, we used a five-step process to search, select, summarize, and organize existing research. The following research question was used to guide this study:

- How has photovoice been used as a pedagogical intervention to promote discovery, evaluation, and exploitation of opportunities in the engineering classroom?

2. Materials and Methods

2.1. Overview

For this paper, we followed a five-step process for the literature review [40–43] that included defining a search criterion, constructing a Boolean logic search query, inserting the query into multiple academic search engines/databases, screening and selecting articles, and categorizing and mapping the literature (Figure 1).

The following sections provide details on the search process, article screening and selection, and literature categorization and mapping for better structure and readability.

2.2. Literature Search Process

The first three steps of the literature review process (Figure 1) correspond to the search process. For Step 1, a general search criterion was defined based on the scope of this study. This included breaking down the research question into individual components such as population, intervention, discipline, and location.

For Step 2, a standard search query was constructed using Boolean ANDs and ORs with synonyms, abbreviations, and alternative terms. This search query was categorized based on discipline, intervention, population, and location for relevant results. For this study, the authors used the following constructed search query—intext:pedagogical inter-vention AND intitle:discipline AND intext:population AND intext:location.
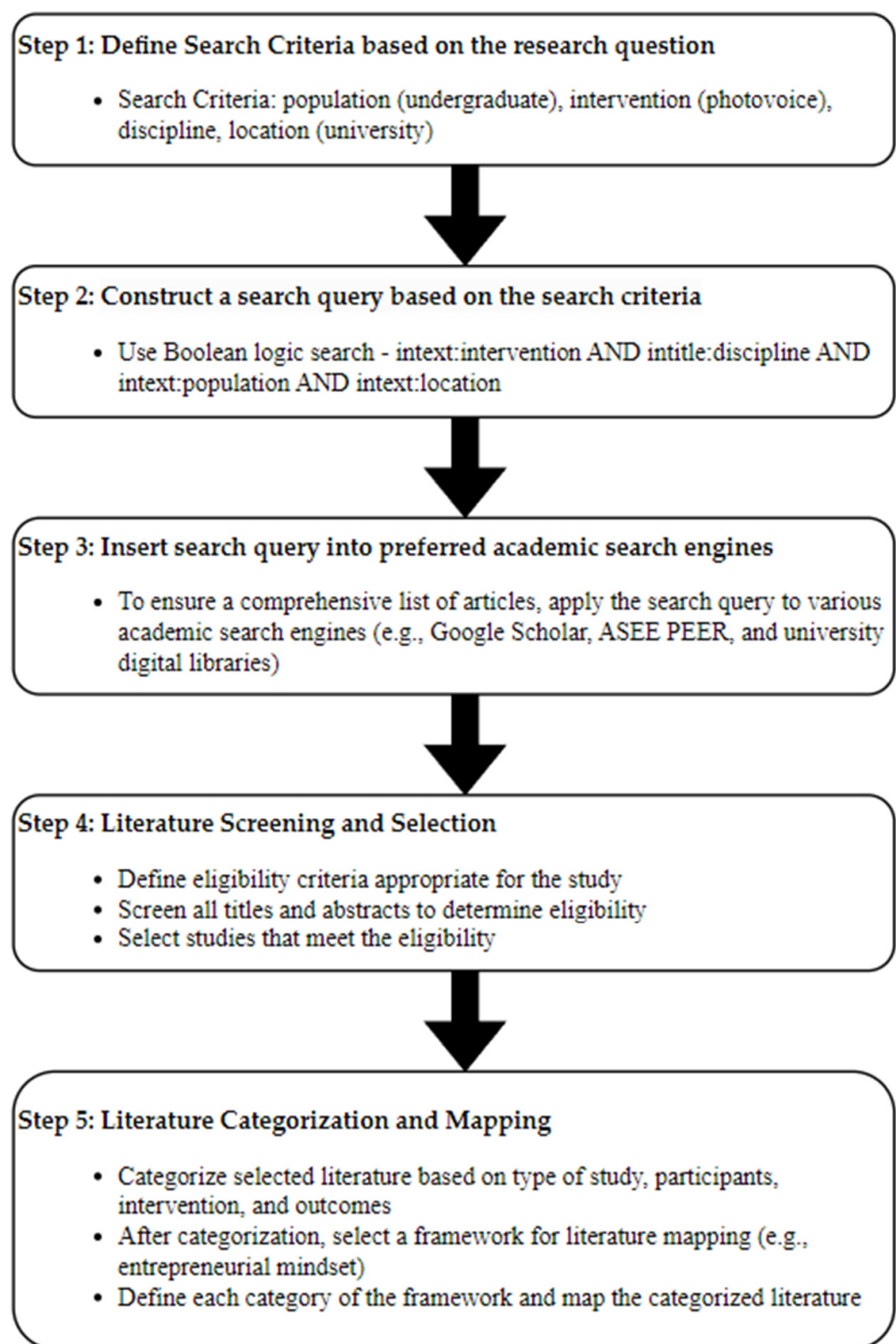
Step 1: Define Search Criteria based on the research question

- Search Criteria: population (undergraduate), intervention (photovoice), discipline, location (university)

Step 2: Construct a search query based on the search criteria

- Use Boolean logic search - intext:intervention AND intitle:discipline AND intext:population AND intext:location

Step 3: Insert search query into preferred academic search engines

- To ensure a comprehensive list of articles, apply the search query to various academic search engines (e.g., Google Scholar, ASEE PEER, and university digital libraries)

Step 4: Literature Screening and Selection

- Define eligibility criteria appropriate for the study
- Screen all titles and abstracts to determine eligibility
- Select studies that meet the eligibility

Step 5: Literature Categorization and Mapping

- Categorize selected literature based on type of study, participants, intervention, and outcomes
- After categorization, select a framework for literature mapping (e.g., entrepreneurial mindset)
- Define each category of the framework and map the categorized literature

Figure 1. Flowchart for literature review process.

For Step 3, the constructed search string was entered into various academic search engines such as Google Scholar, ASEE PEER, and university digital libraries. The University digital libraries include databases such as Scopus, EBSCO, ERIC, and Web of Science. For example, to find relevant literature on photovoice applications in engineering, the following search string was entered into Google Scholar—intext: ("photovoice" OR "photovoice reflections" OR "photovoice metacognitive reflections") AND intitle: ("engi-

neering" OR "engineering technology" OR "engineering course" OR "engineering design" OR "engineering project") AND intext: ("undergraduate" OR "undergraduate students" OR "engineering students") AND intext: ("university"). For ASEE PEER, we used the following search string: "photovoice" + "engineering" + "undergraduate" + "university". Similarly, for the University digital library, we used the following search string: "TI engineering AND TX photovoice AND TX undergraduate AND TX university". After executing all three steps, Table 1 showcases the search results from chosen databases.

Table 1. Search results.

Discipline	Google Scholar Results	ASEE PEER	University Digital Library	Total Number of Search Results (n)
Engineering	242	29	22	293

2.3. Literature Screening and Selection

For Step 4, all 293 records that were identified during the search were screened in two phases. The first phase of screening included keyword and phrase matching (e.g., photovoice, engineering, undergraduate, and university), and the second was for duplicate study screening. After screening, the articles were assessed for eligibility based on abstract reading and full-text reading. To meet the eligibility criteria for the abstract, the following components were included:

1. Intervention: Photovoice was used as a research methodology and as a data collection instrument (e.g., abstract included keywords/phrases such as photovoice reflections, photovoice metacognitive reflections, and photovoice prompts);
2. Participants of the study: Undergraduate students (e.g., abstract included keywords/phrases such as undergraduate students, engineering students);
3. Major/discipline of the participants: Engineering (e.g., abstract included keywords/phrases such as engineering, engineering classroom, engineering technology, engineering design, and engineering project);
4. Location/setting of the study: University classrooms (e.g., abstract included keywords/phrases such as university, and research-intensive or research-focused university).

Articles that satisfied all four components of the criteria [intervention: photovoice, participants: undergraduate students, discipline: engineering, and location: university] were assessed for eligibility through full-text reading. During the eligibility screening phase, we found four articles with overlapping information. To address this, we included one of the three articles for the review, as it provides more details on how photovoice was used.

After careful examination, only 19 articles met the eligibility criteria, while the remaining 274 were excluded from the review. Figure 2 provides a detailed flowchart of the screening and selection process.

2.4. Literature Categorization and Mapping

For Step 5, all selected articles (n = 19) were categorized according to type of study, participants, intervention, and outcomes. After categorization, the literature was mapped based on the entrepreneurial mindset framework [11]. For this paper, the authors defined each category of the entrepreneurial mindset framework as follows:

*   Opportunity Discovery—Literature for this category was chosen based on participant type and participant involvement in the study. For example, studies where the participants/population were only part of the data collection process (e.g., individual reflections, individual photovoice-based interviews) were included in this category.
*   Opportunity Evaluation—Literature for this category was chosen based on participant type and participant involvement in the study. For example, studies where the partici-

pants/population came together to learn more about each other's experiences (e.g., focus groups, small or large group discussions).

- Opportunity Exploitation—Literature for this category was chosen based on participant type and participant involvement in the study. For example, studies where the participant/population established a list of action items for stakeholders to change/reform existing policies and practices (e.g., group-based ideation, sharing reflections with institutional stakeholders).

The literature categorization and mapping process involved reviewing full-text reports (n = 19). This process enabled the authors to review how photovoice-based pedagogical interventions are being used to promote discovery, evaluation, and exploitation of opportunities in today's engineering classrooms.
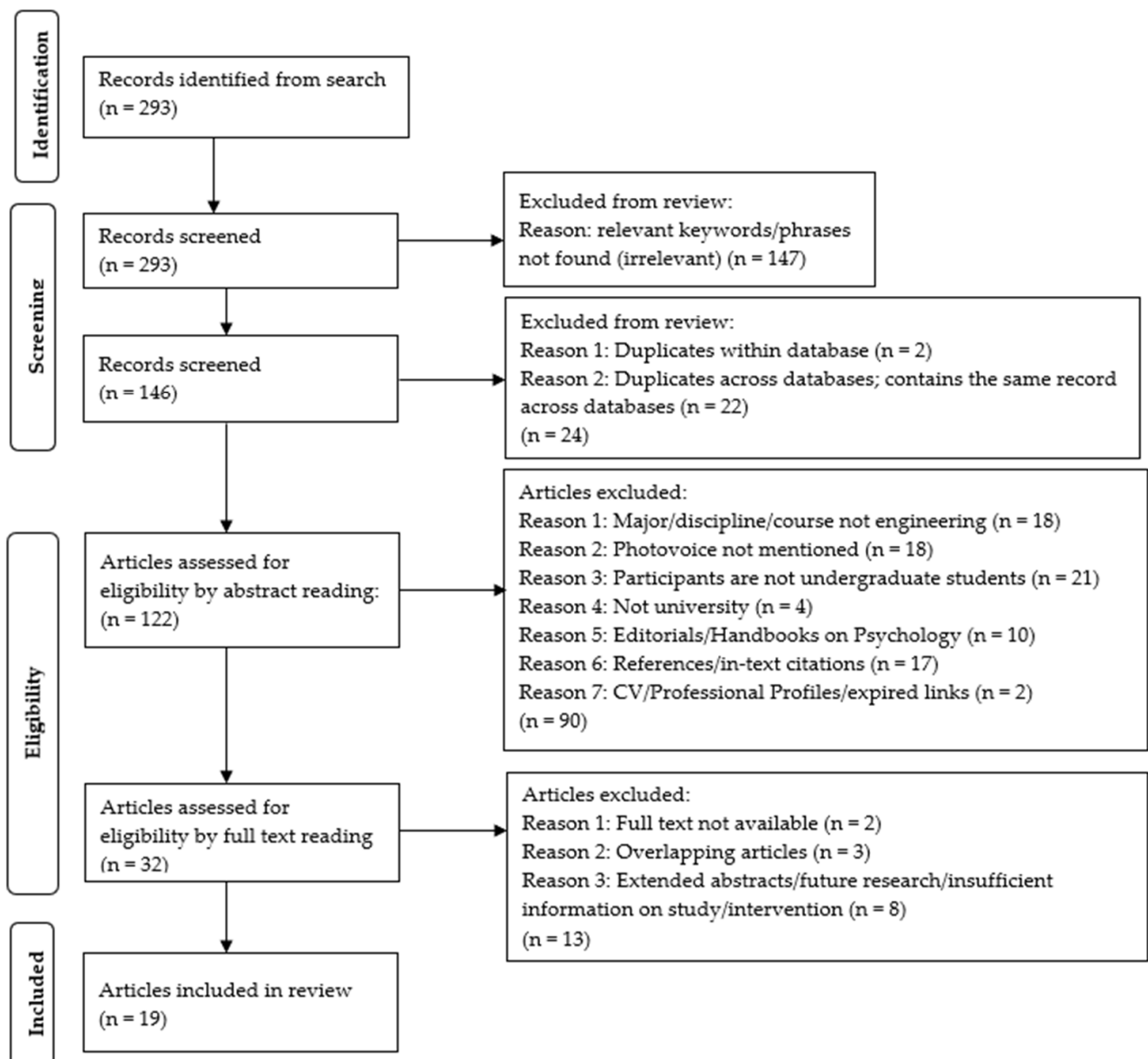

Figure 2. Flowchart for screening and selection process.

3. Results

After reviewing the selected articles (n = 19), the literature was organized based on the type of study and purpose, participants, duration and photovoice interventions used, study outcomes, and entrepreneurial mindset development (Table 2). The table below includes summaries of the studies, current approaches (photovoice interventions), and how photovoice interventions promote entrepreneurial mindset development.

Table 2. Engineering classroom-focused photovoice application.

Type of Study and Purpose	Participants (n) and Description	Duration of Study and Photovoice Intervention	Outcomes	Entrepreneurial Mindset Development
Exploratory: Investigate challenges faced by minoritized students in engineering and the ways they opt to navigate toward success [36].	n = 4 (2 female, 2 male); one student identified as Hispanic/Latino, one as Black African American, one as Black Haitian American, and one as Middle Eastern/Arab. Age range—18–22 years; enrolled in 2nd, 4th, and 5th year engineering programs.	1–2 months; data was collected in four ways: pre-survey, during orientation, and end of orientation, as well as photovoice focus group interviews. During orientation, students were asked to take photos that highlight the challenges and motivators they experienced as undergraduate engineering students.	Empowered students to illustrate and share the barriers they face in engineering programs and increased their level of self-efficacy.	Discovery and Evaluation
Exploratory: Examine the impact of active learning techniques embedded in a formalized mentoring program at an institution serving American Indian students [34].	n = 5 (4 male, 1 female); first-generation students, American Indian, low-income, and pursuing an associate's degree in pre-engineering.	Semester-long (4–5 months); data collected at the end of the semester—photovoice reflections = 3 photos and narratives.	Increased student learning outcomes and enhanced student satisfaction.	Discovery
Exploratory: Showcase photovoice as an approach to understanding student voices and for continuous improvement and new program development purposes [44].	n = 23; enrolled in an industry-based degree program (software engineering) offered in the United Kingdom.	Semester-long course; data collected at the end of semester—photovoice reflections = 3 photos and short narratives (3–5 sentences)	Student reflections were used for course improvement purposes and allowed students to reflect on things that went well and that did not go well during the course.	Discovery

Table 2. *Cont.*

Type of Study and Purpose	Participants (n) and Description	Duration of Study and Photovoice Intervention	Outcomes	Entrepreneurial Mindset Development
Exploratory/Pilot Study: Examine how the racial climate in the United States impacts the experiences of Black undergraduate engineering students [45].	n = 5 (3 female, 2 male). Two students were classified as seniors, two as sophomores, and one as a junior enrolled in various engineering programs. All students identified as Black/African American.	The study included three two-hour sessions: an introductory session, individual photovoice-based interviews, and a focus group discussion.	Empowered students to illustrate and share race-based and other challenges in engineering programs. Students also identified actionable steps to disseminate to university stakeholders in an effort to develop a call to action plan. The photovoice themes were presented to the Associate Dean for Student Affairs.	Discovery, Evaluation, and Exploitation
Work in progress, Exploratory: Examine the lived experiences of sophomore students and how they make sense of their experiences impact on their engineering identities [46].	n = 4 (2 female, 2 male); two students identified as Asian, one as mixed, and one as Latino; three of them were enrolled in the Chemical engineering program and one in the Electrical engineering program.	Semester-long (4–5 months); data collected as follows: pre-survey, photovoice focus groups (beginning, middle, and end of the semester), and semi-structured individual interviews.	Increased ability to elucidate personal experiences.	Discovery and Evaluation
Exploratory: Examine sophomore engineering student experiences and explore how such experiences relate to their identities as engineers [33].	n = 4 (2 female and 2 male); undergraduate sophomore engineering students, ages 18—22. Two identified as Asian-American, one as Latino, and one as biracial.	Semester-long (4–5 months); data collected at three stages—beginning, middle, and end of the semester.	Empowered students to illustrate and share real-time experiences.	Discovery and Evaluation
Exploratory: Examine and propose an approach for a virtual undergraduate research onboarding program to orient engineering students to the NSF REU [47].	n = 15 (7 male, 8 female), enrolled in engineering and engineering technology majors (from universities all across the United States). Out of the 15 participants, 11 were first-generation students.	The study examined the first week of the virtual onboarding program (40 hr). At the end of the onboarding week, a photovoice reflection assignment was administered.	Factors of motivation influencing student enrollment, persistence, and completion of the virtual onboarding program were identified.	Discovery

Table 2. *Cont.*

Type of Study and Purpose	Participants (n) and Description	Duration of Study and Photovoice Intervention	Outcomes	Entrepreneurial Mindset Development
Pilot/Exploratory: Develop, evaluate, and validate the implementation of cybersecurity competitions to improve student cybersecurity competencies through autonomous, collaborative, and personalized learning [48].	n = 55; students were enrolled in a computer science engineering program at a university in Madrid, Spain.	The photovoice research method was used to analyze student learning during a semester-long experience. Students were instructed to take three pictures while completing a design challenge and narrative reflections for each photo. Additionally, reflection prompts were provided.	Photovoice enhanced student motivation and dedication to solving design challenges, and it had an overall positive impact on student mindset.	Discovery
Exploratory: Examine the use of photovoice with entrepreneurial design projects as a high-impact practice in engineering technology education [49].	n = 13 (12 male, 1 female); sophomore-level students enrolled in the engineering technology program.	The project's duration was 4 weeks, and photovoice metacognitive reflection was administered during the 4th week.	Increased student ability to elucidate project experience.	Discovery
Exploratory: Examine the integration of an entrepreneurial mindset in the engineering curriculum to promote socio-technical communication skill development [50].	n = 7 (5 male, 2 female), enrolled in an upper-level undergraduate course offered at a satellite campus of a large, research-focused university.	Semester-long nature-inspired podcast creation curriculum. Photovoice metacognitive reflection was administered at the end of the semester (weeks 14–16).	Student perceptions were identified and were aligned with a framework of motivation. Recommendations were offered for engineering educators to supplement traditional teaching practices with EM.	Discovery
Exploratory: Examine the impact of integrating entrepreneurially minded experiential STEAM learning in a second-year engineering course [51].	n = 6 (5 male, 1 female), enrolled in an industrial engineering course at an ABET-accredited tribal university.	The semester-long project and the photovoice metacognitive reflections were administered at the end of the project.	Improved student satisfaction and motivation amongst Native American students.	Discovery
Exploratory: Examine and demonstrate how student perceptions of learning and learning environment impact student engagement through the integration of EM, STEAM, and bio-inspired design concepts in an engineering course [52].	n = 21 (17 male, 4 female); juniors enrolled in Aerospace and Mechanical engineering programs at Saint Louis University.	The course module/topic duration was one month, and photovoice metacognitive reflection was administered at the end of the module.	Increased student engagement and motivation and professional skill development.	Discovery

Table 2. *Cont.*

Type of Study and Purpose	Participants (n) and Description	Duration of Study and Photovoice Intervention	Outcomes	Entrepreneurial Mindset Development
Exploratory: Examine and evaluate the effectiveness of EM as a framework of curriculum design in the context of machine design and dynamics of machinery [53].	n = 34, enrolled in a Dynamics of Machines course at Colorado State University.	The project-based course was a semester-long, and the photovoice metacognitive reflection was administered to the students upon the completion of the final project.	Increased problem-solving and curiosity to learn and solve real-world challenges.	Discovery
Exploratory: Examine and evaluate the effectiveness of an entrepreneurially minded manufacturing assessment survey assignment administered in a mechanical engineering course [54].	n = 15 (13 male, 2 female), senior-level, enrolled in a manufacturing course offered as an elective in the Mechanical Engineering Department of a research-based university.	The manufacturing assessment survey was given to the students at the end of each week. Photovoice metacognitive reflection was administered during the week when corrosion and erosion topics were taught.	Students exhibited behaviors that aligned with EM skill development (e.g., change in perspective, curiosity, and value recognition of topics taught during the course).	Discovery
Exploratory: Examine the implementation of an Internet of Things (IoT) project in a computer engineering class to promote EM and interdisciplinary research skill development [55].	n = 8, enrolled in a junior-level course (IoT systems design) offered at the Electrical and Computer Engineering Department of a research-based institution.	6-week long project, and the photovoice reflection was administered to the students at the end of the project.	Increased student engagement and participation in the classroom and increased level of persistence and resilience.	Discovery
Exploratory: Examine and demonstrate the effectiveness of the integration of EM, STEAM, and bio-inspired design concepts in an engineering course [56].	n = 54 (46 male, 8 female), enrolled in a first-year engineering course (engineering mechanics). Out of the 54 students, 30 were non-white students.	The course module was implemented during weeks 4–13 of the semester, and the photovoice reflection prompts were administered to the students during week 13.	Increased student engagement, change in perspective while engaging in the project, and identified benefits of brain-storming activities.	Discovery
Exploratory: Examine and demonstrate how student perceptions of learning and the learning environment impact student engagement through the integration of EM, STEAM, and bio-inspired design concepts in an engineering technology course [57].	n = 16 (6 seniors, 10 sophomores), enrolled in a sophomore-level course (programming industrial robots) provided by the engineering technology department of a research-based university.	The robotics project was implemented in three phases during the semester. After the project was completed, photovoice metacognitive reflection was administered.	Increased student engagement, divergent thinking, and class-room collaboration.	Discovery

Table 2. *Cont.*

Type of Study and Purpose	Participants (n) and Description	Duration of Study and Photovoice Intervention	Outcomes	Entrepreneurial Mindset Development
Exploratory: Examine and evaluate the benefits of incorporating interdisciplinary entrepreneurially minded and project-based learning in an engineering technology course [58].	n = 22 (17 male, 5 female); junior—and senior-level students enrolled in industrial engineering technology, mechanical, and manufacturing engineering technology programs.	A mini capstone project was administered during the semester, and the photovoice metacognitive reflection was given at the end of the project.	Increased self-efficacy, recognized the value of the interdisciplinary project, and students supported in the classroom.	Discovery
Exploratory: Examine female undergraduate student experiences in extra-curricular engineering project teams (ESPTs) [59].	n = 10; a general email was sent to all undergraduate female participants who were engaging in ESPTs.	Three semi-structured interviews were conducted, of which only the third used Photovoice. Participants were asked a series of questions, and in addition to their verbal responses, they were asked to assign a photo associated with their answer.	Empowered female participants to share their experiences relevant to ESPTs.	Discovery

4. Discussion

4.1. Summary of Findings

The review's findings (Table 2) showcase how photovoice-based pedagogical interventions are being used in engineering classrooms to promote the entrepreneurial mindset (discovery, evaluation, and exploitation of opportunities). These findings include how photovoice is being integrated into the engineering curricula (intervention), the benefits photovoice offers (outcomes) in the engineering classroom, and the development of the entrepreneurial mindset.

First, after reviewing how photovoice is being integrated into the engineering curricula, it is evident that photovoice has been primarily used as a reflective learning strategy instead of an active learning practice. This finding is attributed to the fact that photovoice has only recently gained popularity in the engineering discipline, and due to its novelty in engineering education research, there are limited examples that offer guidance on its use in classrooms. Hence, it is not surprising to see educators using photovoice to examine or explore student learning experiences.

Second, after reviewing how photovoice-based pedagogical interventions are being used to develop an entrepreneurial mindset, it is evident that photovoice is primarily being used to promote opportunity discovery where participant involvement is limited to providing individual reflections. A total of 15 of the 19 studies mainly promoted the discovery of opportunities in the form of individual reflections. This finding can be attributed to the fact that photovoice has been used as a community-based participatory research tool in health and social sciences to examine issues impacting the population's well-being [60–65]. Hence, it is not surprising to see educators using photovoice for discovery or exploratory purposes in their classrooms.

Third, out of the 19 studies, three [33,36,46] promoted the discovery and evaluation of opportunities where photovoice-based focus group techniques enabled participants to share their reflections with other participants in a small group setting. Furthermore, only one study [45] offered opportunities for the participants to share their reflections (evalua-

tion) with their peers and with the institution's stakeholders for continuous improvement (exploitation). This finding provides evidence that photovoice can be used to cultivate entrepreneurial thinking and for continuous improvement.

4.2. Response to Research Question

In response to the research question, 'How has photovoice been used as a pedagogical intervention to promote discovery, evaluation, and exploitation of opportunities in the engineering classroom?', the literature review's findings revealed that current photovoice interventions are primarily being used to promote opportunity discovery (n = 15) in comparison to opportunity evaluation (n = 3) and opportunity exploitation (n = 1).

For instance, out of the 19 studies reviewed in this paper, 15 focused on examining student learning experiences over the course of a semester or the project's duration. In such cases, the participants reflected on their learning experiences and analyzed their strengths and weaknesses. However, they had limited opportunities to seek feedback or share their experiences with peers. To effectively integrate photovoice into the curriculum and cultivate entrepreneurial thinking, educators should consider offering students opportunities to share and discuss their reflections with their peers (e.g., small group discussions). Such activities will allow them to engage in critical dialogue about persisting issues (e.g., course-related, project-related, challenges/barriers that prevent learning) and identify unexpected opportunities for growth and improvement.

Three [33,36,46] of the 19 studies reviewed in this paper focused on promoting discovery and evaluation of opportunities. In such cases, the participants had opportunities to reflect and share their reflections with peers and instructors through focus group discussions and interviews. However, the instructors/researchers guided these discussions and interviews to steer the conversations around a specific topic or area of interest. While this is a great step in evoking thoughts and ideas and promoting engagement and participation in the classroom, participants might refrain from discussing critical issues that impede their learning. Engineering educators should consider implementing best practices for fostering an open discussion, such as asking open-ended questions, providing guidance on giving constructive and positive feedback to peers (e.g., feedback sandwich technique), and creating a safe and inclusive space for participants to share opinions [66–68].

One [45] of the 19 studies reviewed in this paper focused on promoting discovery, evaluation, and exploitation of opportunities in the engineering classroom. The study's participants had opportunities to reflect, share their reflections through small group discussions, identify opportunities for growth and improvement, and create a list of action items to share with the institution's stakeholders. This study provides a good example and showcases the benefits of photovoice when integrated into the engineering curriculum.

4.3. Compare and Contrast to Literature

To corroborate the findings of this study, previous review papers related to photovoice, and the entrepreneurial mindset were explored. In line with photovoice literature categorization, previous review studies [24,69] categorized the findings based on title, purpose, participant description, duration, research methods, and outcomes. While the discussions in these studies were centered around applications of photovoice for research and pedagogy, they did not offer guidance and recommendations for education practitioners to consider. Other reviews explored how photovoice is used as a research method to promote participant and community change. While these reviews identified gaps in the literature, offered insights, and organized findings based on the scope of the study, no suggestions for improving existing interventions were discussed [63]. Other review papers on photovoice [70,71] discussed gaps and provided recommendations for improvement in terms of application and ethical considerations but did not offer guidance on classroom application. Furthermore, in line with the results discussed in our study, similar review studies [72–75] provided recommendations, guidance, and suggestions for improvements in existing photovoice interventions.

Similar to the structure of our study, a previous review paper [76] discussed the state of entrepreneurial programs in the Science, Technology, Engineering, and Mathematics fields (STEM), identified gaps, and provided recommendations for practitioners and researchers to consider. Previous literature reviews [77–79] were explored for the entrepreneurial mindset. These reviews were conducted to identify classroom practices for promoting the entrepreneurial mindset. Like our study, these review studies followed a standard review protocol for the literature screening and selection process. While these reviews showcased classroom practices for promoting the entrepreneurial mindset and highlighted gaps, no guidance on improvement was provided.

5. Conclusions

Cultivating an entrepreneurial mindset is crucial to better prepare college graduates for working with technology and in fast-paced environments. An innovative pedagogical approach to developing the entrepreneurial mindset is through the participatory action research method, photovoice. In response to the research question, 'How has photovoice been used as a pedagogical intervention to promote discovery, evaluation, and exploitation of opportunities in the engineering classroom?', a literature review was conducted to identify, evaluate, and interpret available research relevant to our research question. The review's findings were organized (Table 2) and discussed to highlight gaps and insights and provide guidance and recommendations for improvement. Based on the review's findings, current photovoice interventions are primarily being used to promote opportunity discovery compared to opportunity evaluation and exploitation. Considering the interventions reviewed in this study, there is room for improvement, especially in how photovoice is integrated into classroom learning and its potential for continuous improvement.

5.1. Contributions

This study provides some noteworthy contributions. First, the five-step process, results, and discussion enable engineering education researchers to identify and synthesize all existing research based on the chosen population, pedagogical intervention, comparison, and context (e.g., photovoice application to promote entrepreneurial mindset). Second, the results and discussion enable researchers to thoroughly review and analyze the literature across various settings and empirical methods. Third, the literature review results provide evidence that supports photovoice-based intervention and ensures its robustness and generalizability, such as replication and applicability across a wide range of settings. Furthermore, our review offers insights, guidance, and recommendations for best practices for engineering education stakeholders to consider.

5.2. Limitations and Future Research

Although the study offers great insights, there are a few limitations to consider. First, the narrow scope of the search process yielded low results. Future research should consider changing the criteria for the literature selection process, which will provide a broader range of options to examine. Second, the study includes literature pertaining to undergraduate engineering education. Future research should consider exploring photovoice applications within various engineering fields (e.g., civil, electrical, computer science, and many more) and across other educational levels (e.g., graduate). Additionally, future research should continue investigating participatory action research methodologies and visual research methods used in qualitative research, such as photovoice and its potential applications in engineering education research.

Conflicts of Interest: The authors declare no conflicts of interest.

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