

Storytelling for Sustainability in Architecture, Engineering, and Construction Education: A Framework

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Abstract

Sustainability is a highly prioritized area of Architecture Engineering and Construction (AEC) education. There are plenty of courses and modules dedicated for this purpose, but the pedagogical approach towards achieving sustainability related learning outcomes is not effective enough to include the complete picture and diversity of constraints related to sustainability. Moreover, an important aspect of sustainability education is to change beliefs and mindsets, which is currently hardly being taken care of. This study attempts to fill this gap by exploring the understudied approach of storytelling for sustainability in AEC education. The framework for creating educational stories is developed matching the literature with AEC educational needs. A pilot story is also created as tested on undergraduate students to demonstrate the utility of framework. The study contributes to the body of knowledge by bringing storytelling as a pedagogical tool one step closer for AEC education.

Keywords

Storytelling, Sustainability, AEC Education

1. Introduction

AEC industry is a large contributor of greenhouse gas emissions and energy consumption. Building operations alone account for around 30% of global energy consumption (IEA, 2023). This highlights the importance of sustainability in AEC education, which the accreditation bodies ensure through the requirement of sustainability learning outcomes for students (NAAB, ABET). Typical classroom settings can use traditional instruction modalities to achieve these outcomes, and there is little to no research on how to optimize learning by

using innovative teaching methods.

Storytelling a promising tool in higher education to help students to engage with sustainability curriculum. Storytelling helps educators share information in an easy, relatable, and accessible manner (Green, 2011). Especially for abstract and multidisciplinary topics like sustainability, stories can create strong, comprehensive examples covering a variety of aspects, and stir up emotions at the same time (Wilson, 2005). Unfortunately, storytelling is highly flexible and not enough empirical evidence available to guide its use for AEC education. This study aims at understanding the dynamics of storytelling and matches it with the needs of AEC education to guide the future educators by developing and testing a framework.

2. Background

Sustainability in AEC Education: Realizing the importance and urgency of sustainable development, UNESCO has urged educational institutions to incorporate sustainability in all aspects of education including the curricula (UNESCO, 2023). Today, sustainability is a key aspect of education in Architecture, Engineering and Construction programs (Boarin et al., 2020; Gutierrez-Bucheli et al., 2022). All relevant accreditation bodies, such as ABET, NAAB, CIDA, and ACCE require the curriculum to include general and field specific education related to sustainability. **Appendix A** presents a list of requirements in the guidelines given by different accreditation bodies. The major themes include dynamics between natural and built environments; principles of sustainability in design and construction; environmental impact of materials and methods; and professional responsibility.

These requirements are met via coursework ranging from sustainability focused modules to general modules with a few elements of sustainability. A study by Boarin et al. on sustainability in Architectural education revealed that one of biggest gaps is an integrated understanding of sustainability by the students that incorporates a variety of disciplines and complex set of needs (Boarin et al., 2020). Similarly, Gutierrez-Bucheli et al. (2022) had similar findings for Engineering education where sustainability outcomes were not being met by the current the modules. That study suggested that the modules lacked the ability to help students develop integrative thinking and change their values and beliefs. These studies suggest that one reason for this gap is that the traditional lecturing methods primarily employed in sustainability courses lack the ability to highlight real and complete issues. This can be solved by using practical examples and real-world problems involving sustainable development (Lim et al., 2015).

What is Storytelling? A story has been defined in multiple ways. Jahn (2005) simply puts it as a “sequence of events which involves characters”. It is the presentation of information in a narrative form, with a clear beginning, a middle and an end (Fischer et al., 2020). There is emotional content and sensory detail in stories absent in simply giving an example (Simmons, 2001). A story is a narra-

tive presentation of information involving characters, along with their interactions and emotions, with a clear beginning, middle and end. There is a variety of language used by different authors related to the structure and components of a story. [McConaughy \(1980\)](#) stated that a story, in one way or another, has the following chronological components: 1) a setting, which presents the characters, location and circumstances; 2) an initiating event, which forms the basis for characters to develop goals and take actions; 3) the goal, which is the main purpose of the protagonist/s in the story; 4) a number of attempts, which are the actions of the characters; 5) a series of outcomes, which are the situations, states or events created by actions of the characters; 6) internal responses, which are the subgoals, thoughts and feelings of a character leading to his or her actions; and vii) reactions, which are thoughts or feelings produced by the outcomes of actions. Recently, [Fischer et al. \(2020\)](#) came up with a model showing key features of a storytelling, listed in [Table 1](#).

Table 1. Features of Storytelling; adopted from [Fischer et al. \(2020\)](#).

Feature	Description
Plot	Sequence of action events within a narrative structure. The guiding principles for such events can be adventure, love, discovery etc.
Personalization	Characters and their experiences.
Dramaturgy	Problems and conflicts and evolves towards solutions.
Chronology	A beginning, a middle and an end.
Context	Information about time, space, culture and other settings.
Stylistics	Different style devices used in story such as a metaphor or an alliteration.
Tonality	Tone such as serious, humorous, scary etc.
Modality	The mode of presentation, such as video, audio, interactive etc.

Why is storytelling effective? Human beings are hard wired to take interest and relate to stories ([Haven, 2007](#)), and storytelling has a strong presence and impact in human history. Storytelling has many functions at individual, organizational and social levels that have been highlighted in literature ([Leung & Fong, 2011](#)). Some of the major themes in this regard include enhancing knowledge, connecting people, remembering information, envisioning the future, preservation of culture, transmission of values, promotion of action, and assistance in change process ([Thier & Erlach, 2005](#); [Denning, 2004](#); [Sunwolf & Frey, 2001](#)). Regarding education, storytelling helps in a) creating interest, b) providing a structure for remembering course material, c) sharing information in a familiar and accessible form, and d) creating a more personal student-teacher connection ([Green, 2011](#)). Stories provide knowledge in an interesting, appealing, comprehensive, and stimulating way ([Dahlstrom, 2014](#)). They help students contem-

plate and create a sense of the world around them, and in the process create a strong sense for self (Landrum et al., 2019).

Storytelling for Sustainability: Storytelling is very effective for abstract and inaccessible information where stories can provide strong examples and evoke emotions at the same time (Wilson, 2005), so it is a great match for sustainability education. Stories for sustainability are designed to achieve outcomes promoting sustainable development and provide improved reflections and change of mind (Fischer et al., 2020). Bernier (2020) found that good sustainability stories are purposefully designed to educate and empower the audience by providing vivid and compelling examples of sustainability in practice. His tips for crafting an effective sustainability story are listed in Table 2.

Table 2. Tips for crafting an effective sustainability story (adopted from Bernier, 2020).

Area	Tips
Aim	The aim of a good sustainability story shall not be merely educating the audience, but also to change their behavior and empower them.
Approach	The story shall not describe facts and data and prescribe solutions like a research paper. Instead, it shall humanize the problems and legitimize with well-placed data. It shall show and not tell what to do.
Audience	The story shall be designed with the nature and priorities of the audience in mind in order to capture their interest.
Content	<ul style="list-style-type: none"> The plot shall preferably revolve around individual characters and not organizations, so that the individuals can relate more. First, introduce the problem properly, and then seek and implement a solution. Take the unique impact of the location and time into consideration.
Conflict	<p>The story shall capture the challenge of sustainability in a comprehensive manner, which can include one or more of the following types of conflicts:</p> <ul style="list-style-type: none"> Person Against Person Person Against Self Person(s) Against Nature Person Against Society

3. Methodology

The study was conducted in three stages: 1) Development of a framework for storytelling for sustainability in AEC education; 2) Designing a story using the framework; and 3) Pilot testing the story on students. The framework was developed using inspiration from recent endeavors in storytelling for sustainability and tailoring it to the unique educational requirements of the AEC higher education. Once the framework was developed, it was used to create a story in video mode following the framework protocol. The framework development and story creation are detailed in the results section.

Finally in the third stage, the story was put to a pilot test on students of an undergraduate course at a large public university in the Midwest region of the United States. The course was completely online and covered the foundations of sustainable building design. There were 213 students with diverse majors including Architecture, Civil Engineering, Interior Design, Education, Law, and Business. Data was collected in the month of March 2024. All students received a request to fill out an anonymous online questionnaire, followed by a reminder a week later. Since it was a pilot test with no demographics collected, the responsible IRB approved it as an Exempt project. There were two main parts of the questionnaire. The first part used a pre and post structure to record the knowledge gain by the students. They were asked the same multiple-choice questions (five in number) before and after watching the story. The second part of the questionnaire consisted of a feedback portion using Likert scale where students shared if they found learning through storytelling more interesting, valuable, inspiring, appealing, and effective as compared to traditional learning through lectures. Both portions of the survey are provided in **Appendix B**. Descriptive statistics and paired samples T-test were used for analysis of data.

4. Results

4.1. Storytelling for Sustainability and AEC Education— A Framework

Given the effectiveness of storytelling for sustainability, AEC education can hugely benefit from its use. This section focuses on sustainability in AEC education and proposes a framework, shown in **Figure 1**, for AEC educators to design stories that are both informative and impactful for the students.

The first step is to decide a basis or aim for developing the story. Since, AEC education pertains to a certain industry, it is expected for the stories to educate and inspire the students within the domain of the industry. Nevertheless, this limitation still provides endless variations and combinations of desired outcomes. In a nutshell, the sustainability story for AEC education would target for an increased knowledge, awareness and motivation for one or more of the following: a) Dynamics between built environment and natural environment; b) Principles of sustainability in architectural design; c) Principles of sustainability in design; d) Environmental impact of construction; e) Methods of construction in relation of sustainability; f) Properties of construction materials in relation to sustainability; and g) Professional responsibility with regard to environment. We have named these areas as *Educational Themes*.

Once the educational themes of a story to be developed are decided, the next step is to design the components. The *context* can be any time, place, and conditions, even if it is imaginary or fictional. However, it is advised to keep the stories relevant and factual for young adult audience (Fücker et al., 2023). Therefore, a place and time that the students can relate to would be more effective. For example, for students in the US, the stories from United States in current or re-

cent times would generally have a bigger impact on the students. In terms of *plot*, there is no rule on how long a story shall be in literature. However, the story needs to be both educational and engaging at the same time (Bernier, 2020), and long stories lose the interest of readers/audience (Tierney & Dobson, 1995). Therefore, the stories shall be reasonably long, that may be assessed with feedback. The *characters* used shall be individuals, in place of organizations, as mentioned before (Bernier, 2020). The *drama or conflicts* shall represent a holistic set of constraints around the problem, rather than making it hero vs villain scenario. For example, the protagonist may be challenged by other individuals, but also the society, the system and perhaps herself. Since one of the major aims of AEC sustainability stories is education, therefore a more serious and concerned *tone*, as compared to light and humorous, is expected to stimulate the learning process and bring about a conceptual change (Downs, 2014). There are multiple *modes* that are available to develop a story, ranging from a very traditional reading to virtual reality. Though the new high-tech and innovative forms of storytelling have their merits (Fischer et al., 2020), it is not usually possible for higher education educators to use these expensive and complex means. However, as compared to reading, a video-based story has clear benefits (Finkler & Leon, 2019), and therefore should be prioritized whenever possible.

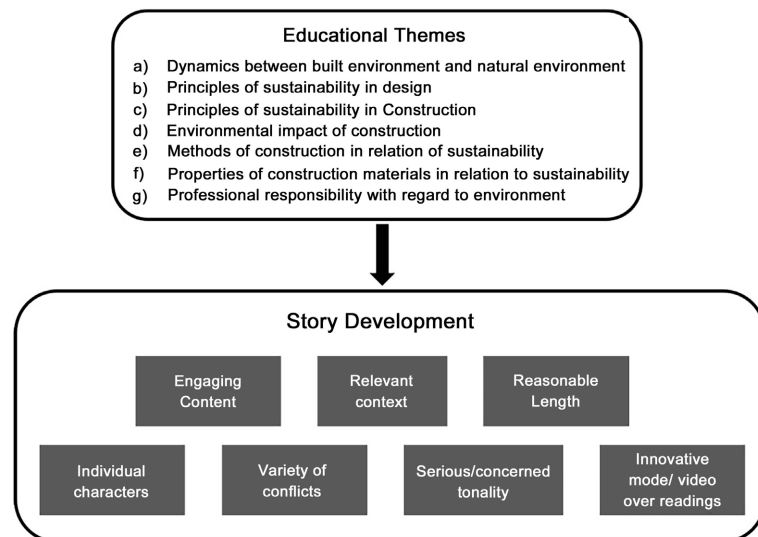


Figure 1. AEC storytelling for sustainability framework.

4.2. Creation of the Story

The first preference of authors was to find a true story within the United States to make it more relevant and convincing. The story selected was of a Physician in Florida who wanted to install solar panels on his newly constructed office building and struggled due to multiple constraints. This story pertains to the themes of the principles of sustainability in design, and the principles of sustainability in construction. The learning objectives include knowledge about basics of photovoltaic energy, types and characteristics of solar panels, different re-

quirements of solar installation and the incentives offered by governments for solar energy use. The story was narrated by the daughter of the main character and shot on a 7-minute-long video including pictures and texts at multiple instances. This is a good length of the video as longer than 10-minute length can make the videos less memorable, engaging, and effective (Slemmons et al., 2018). A chronological summary of the story narrative is presented in **Table 3**.

Table 3. A chronological summary of the story narrative.

Story Element	Narrative Summary
Introduction	The main character is introduced, who is a doctor in Florida
Intent	The doctor decides to install solar panels on his new office building.
PV power and Crystalline Panels	Information about PV power and traditional crystalline panels is shared.
Conflicts	The doctors face roadblocks to execute his plan.
Thin film panels	Crystalline panels are not possible; therefore, the doctor comes to know about thin film panels.
Struggle	The doctor goes on a long journey of permissions and permits.
Rebates	Surprisingly, the doctor gets a big rebate on his roof due to solar.
Incentives	Loans and rebates provided by cities to encourage solar is introduced.
Electricity Bill	The doctor gets bills after months due to some confusion, but even together they are extremely low.
Payback period	The story ends with information on payback periods of solar installations.

4.3. Data Collection and Analysis

Out of the class of 213, a total of 69 students participated in the study. Further, 47 of the participants either left their forms blank or just filled the pre story survey, leaving with only 22 responses eligible for the study, making the response rate of 10.3 %. The results of the statistical analysis for the pre-post-story responses are presented in **Table 4**. The correct answers were coded as one and the wrong answers were coded as zero.

The feedback questions used a five-point Likert scale ranging from strongly disagree to strongly agree. The frequencies of responses are shown in **Figure 2**.

Table 4. Pre and post story test results.

Question	Pre-Story		Post-Story		Test Statistic	P-value
	Mean	Std Deviation	Mean	Std Deviation		
Q1	0.59	0.503	0.77	0.429	-1.702	0.104

Continued

Q2	0.14	0.351	0.86	0.351	-7.483	0.000**
Q3	0.09	0.294	0.73	0.456	-6.062	0.000**
Q4	0.32	0.477	0.68	0.477	-2.935	0.008**
Q5	0.23	0.429	0.77	0.429	-5.020	0.000**

**pre and post story differences are significant at a 99% confidence interval.

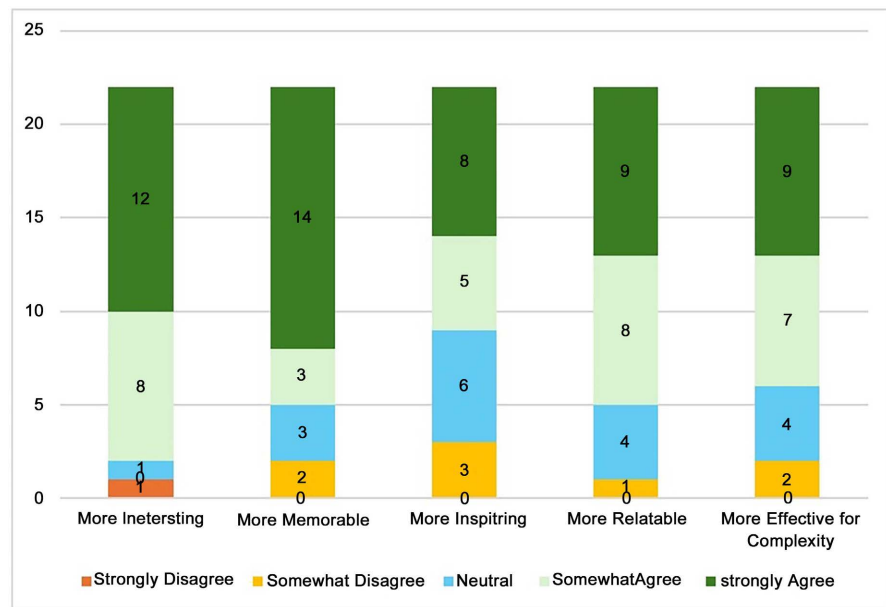


Figure 2. Participants' perception of storytelling.

5. Discussion

This study is the first of its kind to propose and test a framework for storytelling focused on sustainability in AEC education. Storytelling has always remained a part of human history. However, creating standard frameworks and strategically using them in education is a relatively new effort (Fischer et al., 2020). The study reviewed the storytelling for sustainability literature and paired it with the specific needs of AEC education. Moreover, a pilot story was developed and tested using the framework for its effect on both learning and perceptions of students. The results indicate that storytelling is effective in significantly improving the knowledge of students regarding sustainability. Moreover, majority of the students agreed on all the metrics that present storytelling as a better means of instruction, providing validity to the literature.

The framework proposed in this study contributes to the storytelling literature by providing new reflections on elements like industrial context, video as a suitable medium, suitable length of the story and the right tonality. It provides a valuable new perspective to AEC research for education in general and sustainability education in particular. This is not the first study of storytelling in AEC. There have been some strong efforts recently, such as using immersive storytel-

ling of construction workers to help students visualize the nature of job and inspire them to join the construction management field (Wen & Gheisari, 2021). But this study is theoretically novel in two different ways. First, it creates a strong foundation in form of a framework that provides reliability and the potential of replicability in various contexts. Second, this study focuses specifically on sustainability education in AEC. The most important contribution, however, is the practical one. This study has clearly laid out all the guidance along with an example demonstration for instructors of AEC as well as other applied fields of higher education to conveniently use storytelling as a means of instruction for all the benefits of increased interest, memory retention, inspiration, relatable content, and especially dealing with complex topics.

There are some limitations to this study. The story was developed using a video with a person's narration and supporting images. A more enacted and dramatic video with multiple actors and could have had more emotional impact. The data collection was limited to a simple anonymous questionnaire. Therefore, the study missed collecting a lot of qualitative data in form of demographics, and detailed feedback using interviews or focus groups. Future research should make up for this by conducting more in-depth studies with a larger sample size. Moreover, there is a great lack of empirical evidence in this area. Hence, there is a great need of developing and studying stories in all kinds of industries and for all kinds of topics. Only then will we be able to perfect our stories with optimized features.

6. Conclusion

This study was intended to develop a framework for educators to develop stories for sustainability in AEC education. A comprehensive review of literature was performed to understand the requirements of sustainability in AEC education, structure of storytelling, and particular treatment of storytelling for sustainability. This helped us narrow down the storytelling literature for AEC and propose a hands-on framework ready to be utilized in classroom. A pilot story was developed and tested using the framework which gave positive results in terms of learning and favorable student perceptions. Despite the promised potential of storytelling in education, there is little empirical evidence available to assess the optimum features according to the audience. Future research can help fill this gap by more in-depth studies, increased sample sizes, and diversity of content. Hopefully, the framework presented here above can help AEC and other educators in adopting storytelling-based education.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix A

Sustainability related Accreditation Requirements by AEC Accreditation bodies.

Body	Document	Requirement
ACCE	Document 103: Standards and Criteria for the Accreditation of Construction Education Programs	Student Learning Outcome No. 15: Understand the basic principles of sustainable construction. (pg. 11)
NAAB	NAAB Conditions for Accreditation, 2020 Edition	Program Criteria No. 3 Ecological Knowledge and Responsibility: How the program instills in students a holistic understanding of the dynamic between built and natural environments, enabling future architects to mitigate climate change responsibly by leveraging ecological, advanced building performance, adaptation, and resilience principles in their work and advocacy activities. (pg. 2)
CIDA	CIDA Professional Standards 2022	Standard 13. Products and Materials. (e) Students select and apply products and materials on the basis of their properties and performance criteria, including ergonomics, environmental attributes, and life safety. (pg. II-30) Standard 15. Construction. (a) Students have awareness of the environmental impact of construction. (pg. II-32) Standard 16. Regulations and Guidelines (b) Student work demonstrates understanding of: standards and guidelines related to sustainability and wellness. (pg. II-35)
ABET	Criteria for Accrediting Applied and Natural Science Programs	General Criteria for Baccalaureate and associate degree Programs Criterion 3. Student Outcomes (5) An ability to understand ethical and professional responsibilities and the impact of technical and/or scientific solutions in global, economic, environmental, and societal contexts. (pg. 6) Program Criteria for Construction management and similarly named programs. Curriculum (7) Project sustainability including materials, methods of construction. (pg. 9)
	Criteria for Accrediting Engineering Programs	Program Criteria for Architectural and similarly named Engineering programs. Curriculum (e) Considers fundamental attributes of building performance and sustainability. (pg. 20) Program Criteria for Civil and similarly named Engineering programs. Curriculum Include principles of sustainability in design. (pg. 24)

Appendix B

Elements of online Survey Questionnaire

Part 1: Pre/Post Test	
Question	Multiple Choices
The two well-known types of solar panels are _____.	1) Crystalline Silicon and Metal 2) Crystalline Silicon and Thin film 3) Metal and Thin film 4) Metal and Plastic
The efficiency of Crystalline solar panels is roughly _____.	1) 60% - 74% 2) 32% - 46% 3) 13% - 19% 4) 4% - 12%
The efficiency of thin film solar panels is roughly _____.	1) 60% - 74% 2) 32% - 46% 3) 13% - 19% 4) 4% - 12%
Cities may provide incentives such as loans and _____ for solar system installations.	1) Guarantees 2) Kudos 3) Rebates
The average payback period for solar panels is _____.	1) One to two years 2) Three to five years 3) Six to ten years 4) Twelve to fifteen years
Part 2: Feedback on Learning through Storytelling	
As compared to a traditional lecture, I find storytelling more interesting.	
As compared to a traditional lecture, I find a storytelling more memorable.	
As compared to a traditional lecture, I find a storytelling more inspiring.	
As compared to a traditional lecture, I find storytelling providing real life examples more relatable.	1) Strongly Disagree 2) Somewhat Disagree 3) Neutral 4) Somewhat Agree 5) Strongly Agree
As compared to a traditional lecture, I find storytelling more effective in communicating the complex and multidimensional topics such as solar system installation.	