

Identifying and Shifting Educators' Failure Pedagogical Mindsets Through Reflective Practices

Educators' Failure Pedagogical Mindsets

Amber Simpson^{*1}, Alice Anderson², Megan Goeke³, Dara Caruana¹, and Adam V. Maltese⁴

¹ Binghamton University

² Forum for Youth Investment

³ Science Museum of Minnesota

⁴ Indiana University

*Corresponding author information: Amber Simpson, P.O. Box 6000, Binghamton, NY 13902, United States, (e-mail: asimpson@binghamton.edu).

Abstract:

Background: In this paper, we add to the scant literature base on learning from failures with a particular focus on understanding educators' shifting mindset in making-centered learning environments.

Aims: The aim of Study 1 was to explore educators' beliefs about failure for learning and instructional practices within their local making-centered learning environments. The aim of Study 2 was to examine how participation in a video-based professional development cycle regarding failure moments in making-centered learning environments might have shifted museum educators' failure pedagogical mindsets.

Sample: In Study 1, the sample included 15 educators at either a middle school or museum. In Study 2, the sample included 39 educators across six museums.

Methods: In Study 1, educators engaged in a semi-structured interview that lasted between 45-75 minutes. In Study 2, the six museums video recorded professional development sessions.

Results: Results from Study 1 highlighted educators' failure pedagogical mindsets as either underdeveloped or rigid, and absent of relational thinking between self- and youth-failures. One key result from Study 2 was a shift from an abstract sense of failure as youth-focused to a practical sense of failure as educator-focused and/or relational (i.e., youth-educator focused failure moments).

Conclusions: Based on the results from Study 1 and Study 2, our research suggests that exploring an educator's relationship with failure is important, and witnessing and reflecting upon their own failure pedagogical mindset in action may facilitate a shift towards a more complex and interconnected space for growth and development of both educators and youth.

Keywords:

Educators; failure pedagogical mindset; instructional approaches; professional development; video-based reflection

Conflict of interest:

The authors declare no conflict of interest.

Data availability statement:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgements:

This material is based upon work supported by the National Science Foundation under Grant No. 1623452, as well as supported by the National Science Foundation under Grant No. 2005927 (Binghamton University) and Grant No. 2005860 (Indiana University). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Author Contributions

Conceptualization: AS, AA, AM; Formal analysis: AS, MM, MG, DC; Funding acquisition: AS, AA, AM; Investigation: AS, AA, GM, AM; Project administration: AS; Writing – original draft: AS, AA, MG; Writing – review & editing: AS, AA, MG, AM

Identifying and Shifting Educators' Failure Pedagogical Mindsets Through Reflective Practices

Introduction

"I don't necessarily give enough time for people to figure it out on their own.

So like, I was trying to help a little bit too much." (Callie, Participant)

Teaching and facilitating learning experiences inherently involves uncertainties and failure moments for educators (Helsing, 2007; Zimmerman et al., 2022). As educators, talking about and reflecting upon failure moments with others are rare and scarcely explored (Lutovac, 2019; Sudzina & Knowles, 1993) but has the potential to support educators in broadening and improving upon their instructional approaches (Lutovac & Flores, 2021; Starrett et al., 2023). Additionally, as stated by Lutovac and Flores (2021), "experiences of failure have the power to define how teachers see themselves and ...[their views] about teaching and learning and being a teacher" (p. 380). For example, elementary pre-service educators' perceived failure experiences (e.g., ineffective teaching approach) influenced their future-oriented identities as educators. More specifically, educators' perceived failure experiences informed future areas for growth and the integration of "effective" instructional approaches to support students learning through failures and errors (Lutovac, 2019; 2020).

Additionally, to understand educators' reflections on and dialogue about failure moments, we should also consider scholarship regarding the influence of educators' mindsets on children and adolescents (Yeager & Dweck, 2012). As described by researchers, failure mindsets are evident to others, including children (Haimovitz & Dweck, 2016) and post-secondary students (Muenks & Yan, 2022). Haimovitz & Dweck (2016; 2017) identified that adults' failure mindsets shape children's mindsets through their actions and words, which may be associated

with children's ability to perceive adults' failure mindsets. For example, parents who view failure as a debilitating experience that hinders learning had children who were more likely to have a similar mindset (i.e., fixed mindset) regarding their intelligence. Similarly, educators' mindsets influence their pedagogical strategies and work engagement (Muenks & Yan, 2022; Nalipay et al., 2021; Zarrinabadi & Afsharmehr, 2022), as well as shape students' classroom experiences (Frondozo et al., 2022; Kraker-Pauw et al., 2017), and course grades and attendance (Shoshani, 2021). For instance, Muenks and Yan (2022) found that students with STEM professors with a failure-as-debilitating mindset reported learning less, and described the course and the environment negatively. As another example, Nalipay et al. (2021) discovered that educators with a growth mindset enjoyed teaching, were energetic, and demonstrated persistent and effort in their work. To date, the majority of this research is grounded in classroom settings that is often tied to educator and student performance or competency as opposed to an out-of-school setting where performance and assessment of content is not a priority. As children only spend about 18.5% of their waking hours in classroom settings (National Research Council, 2009), out-of-school settings – including the educators who teach in them - may serve as another critical setting influencing children's developing mindsets.

Many educators also recognize how experiences with professional failures may be intricately connected with youths' failure moments (Lottero-Perdue & Parry, 2017; Lutovac & Flores, 2021). This research often examined the positive and/or negative responses and messages from educators when youth experienced struggles and/or failure moments (e.g., not meeting a goal defined by self and/or others). Positive responses can be described as instructional approaches aimed at transforming potential negative experiences and emotions of youth (e.g., quitting, frustration, embarrassment) into positive experiences and emotions (e.g., iteration,

collaboration) (San Juan & Murai, 2022). Examples of positive responses may include encouraging failure analysis, observing the prototype of others, providing suggestions, celebrating failures, and asking questions (e.g., Lottero-Perdue & Parry, 2017; Maltese et al., 2018; Ryoo et al., 2015; Warshauer, 2015), as well as voicing phrases such as “failure is a learning opportunity” or “it is okay to fail” or “it is important to persevere: to try again and not give up if you fail” (Lottero-Perdue & Parry, 2017, p. 15). Haimovitz and Dweck (2016) may refer to these positive responses as exhibiting a failure-as-enhancing mindset. Conversely, negative responses may be considered as removing opportunities for youth to learn from their failures or make progress toward meeting some goal or expectation such as providing direct instruction or taking ownership of the object (Simpson et al., 2019; Warshauer, 2015). Yet unlike the opening quote in which an educator reflected upon and shared their response to a child’s failure as their own facilitation “failure” to their peers, such moments are rare in the current literature base.

Therefore, in this paper we seek to add to the scant literature base on learning from failures with a particular focus on understanding educators’ mindsets regarding failure moments, and their actions in response to failures, in making-centered learning environments. Broadly, the concept of mindset is associated with growth and fixed mindsets (Dweck, 2006). Individuals who embrace a growth mindset perceive success as a result of dedicated effort and view setbacks as valuable chances for personal development. In contrast, individuals with a fixed mindset tend to place their beliefs in inherent abilities, interpreting failure as a personal deficiency, and consequently, allowing it to negatively shape their self-perception. Within this fixed mindset framework, there exists limited space for both failure and personal growth. Building upon the scholarship of Dweck (2006) and Haimovitz and Dweck (2016), we define a failure pedagogical

mindset as (a) a set of beliefs through which educators make sense of failure within their professional work environments and situations (i.e., failure mindset) and (b) how educators perceive their instructional practices and responses to failure moments as effective or not effective. It is a mindset in which a “combination of cognitive filters and processes through which professionals interpret their professional environments and execute their professional responsibilities” (Mintchik et al., 2021, p. 87). This perspective aligns with the dominant focus of mindset as a belief about one’s human characteristics as either static or dynamic (Dweck & Yeager, 2020), but also a mindset grounded in andragogical learning in that educators determine the what, how, and why of their learning possibilities as fostered through a professional development learning environment (Booth & Segon, 2009).

In our research, we focused on educator failure pedagogical mindsets within making-centered learning environments. Making-centered learning environments center learning through activities involving building, designing, adapting, and/or repurposing materials and objects into a digital and/or physical prototype or product (Vossoughi & Bevan, 2014). Such learning environments tend to include a variety of physical and digital tools and materials (e.g., cardboard, pipe cleaners, circuit boards, conductive ink, and computer programming software) for the creation and iteration of prototypes or products. Further, making-centered learning environments often emphasize and embrace failure moments as part of the process in developing prototypes (Lock et al., 2020; Martin, 2015), which sets this environment apart from other learning environments, such as math and science classrooms, in which failure is viewed as associated with grades and a reflection of the learner as incompetent (e.g., Heyd-Metzuyanim, 2015).

Informed by prior research (e.g., Haimovitz & Dweck, 2017; Kraker-Pauw et al., 2017; Shoshani, 2021), we began with an exploratory study (referred to as Study 1) in 2017 to understand educators' beliefs about failure for learning and their instructional practices within their local making-centered learning environments. The results from Study 1 highlighted educators' failure pedagogical mindsets as either underdeveloped or rigid, and absent of relational thinking between self- and youth-failures. Based on the findings from this study, our research team collaborated with six museums across the United States, to modify and implement a professional development (PD) cycle based on Borko and colleagues' (2015) work with mathematics educators as an approach to support the growth and development of educators' awareness of and response to errors/failure moments. As such, this support was garnered through video recordings as "video allows one to enter the world of the classroom without having to be in the position of teaching in-the-moment" (Sherin, 2004, p. 13). Additionally, research has highlighted how educators are able to engage in a collaborative endeavor around shared experiences, co-construct and validate particular practices, and discuss ideas for growth through the integration of video clips in PD settings (e.g., Borko et al., 2008, Grabman et al., 2019; Tran et al., 2019). In this study (referred to as Study 2), we considered museum educators' errors/failure moments as reflected upon within an ongoing professional development model that used video sharing as a reflection tool. The purpose of this study was to examine how participation in a video-based professional development cycle regarding failure moments in making-centered learning environments might shift museum educators' failure pedagogical mindsets. Through the results from Study 1 and Study 2, we argue for the inclusion of a reflective learning environment, particularly a video-based reflection environment, for educators to develop, refine, and/or enhance their failure pedagogical mindsets. Our research suggests that

exploring an educator's relationship with failure is important, and witnessing and reflecting upon their own failure pedagogical mindset in action may facilitate a shift towards a more complex and interconnected space for growth and development of both educators and youth.

Methods

For the both studies, approval was obtained by the appropriate institution research ethics committee. Each partnering organization identified educators to be a part of our studies. Each educator was sent information about the project and research study via email and provided informed consent through a virtual format. Educators were still able to be a part of the project but not consent to be a part of the research component.

Study 1

Participants

This study included two organizations in which making-centered learning was a core part of their educational values and practices. One organization was a middle school in the Southeast region of the United States that integrated hands-on, creative and making-based projects into core curriculum classes as well as their design, arts and media classes (e.g. making a paper circuit light up greeting card, choosing an independent project using woodworking, sewing and digital design). The second organization was a science museum in the Midwest region of the United States that offered week-long summer camps and other museum-based programming for many years (e.g. a carpentry pinball camp, learning the Scratch coding program).

The learning environment in this study was educators' natural environment, their classroom, camp setting, and/or open-making exhibits and programs. This extends beyond the physical space but includes the pedagogical features, the educator-student interactions, the making-centered task, materials and resources, and norms and expectations that are parse and

parcel of the educators' teaching and learning environment. As such, the environment is a place for educators to hack, reflect, adapt, design, create, and deepen their pedagogical approaches and identities as educators through their failure experiences (Bullock & Sator, 2017; Lutovac, 2020).

Participants in Study 1 included eight educators in the middle school and seven educators at the science museum who worked directly within the maker-centered learning programs ($n = 15$). The sample included four men and eleven women. No other demographic information was collected from participants.

Data Sources

We used a semi-structured interview protocol with all educators about their beliefs of failure broadly, the role of failure in making-centered learning, and their instructional practices regarding learner failure. Example interview questions included: What are some words that come to your mind when you hear the word "failure" within a making context? How do you typically respond to youth when they experience failure within a making context? (see Online Resource 1). Interviews lasted between 45-75 minutes and were audio recorded and transcribed.

Data Analysis

The interviews were conducted by three researchers involved in the project, and coded by the second and third authors, with guidance from the first author. We outline our steps for transparency. The transcripts were first coded for statements that related to one of eight core questions (e.g. failure description, pedagogical strategies) (Saldaña, 2012). As participants sometimes gave responses related to multiple overarching interview questions, codes were applied based on the content of responses, not just the immediately preceding interview question. As an example, the following quote was coded as pedagogical strategies: suggest peer support, as well as failure mindset due to the notion of a good model versus a successful model.

Somebody'll have a really good model, you know, a success – I shouldn't say good – a successful model, and the kid next to him is really struggling. I'll say, "Could you, you know, talk to each other, and can you suggest different things that would work and show him how yours is working and go from there?"

Next, to address the purpose of the study, the second and third authors wrote analytical memos around the following codes (Birks et al., 2008): (a) description of failure ("learning opportunity", "giving up") , (b) failure mindset (e.g. educators' beliefs of failure within their workplace environment), and (c) pedagogical moves (e.g. ask questions, set an expectation that failures will happen). This was done for each participant. In meeting to discuss the patterns in the data captured through the researcher-written memos, an additional pattern was discovered in response to the memos about educators' beliefs of failure and their pedagogical strategies - tensions in practice. Consider the following memo from the third author: "Talked about tension of time and promised outcomes of program limiting exploration (have to have the promised product at the end of the week)." Both classroom and museum educators agreed that failing was an important part of a learning process, but several tensions limited their ability to effectively tie their beliefs with their instructional choices. This pattern is highlighted in the findings as such tensions around intentions and reality, particularly educators' beliefs about failure for learning and their instructional practices within their local making-centered learning environments (i.e., failure pedagogical mindsets) informed the design of Study 2.

Study 2

Participants

Across the six partnering museum sites, 39 educators were involved in the PD cycles, of which 33 provided demographic information. The educators had a range of experience as a

museum educator with the majority of the educators ($n = 18$, 55%) having less than three years of experience, seven (21%) between 4-6 years of experience, three (9%) between 7-9 years of experience, and two (6%) had more than 10 years of experience. This may also be reflective of educators age. Twenty-one educators (64%) were between 20-29 years of age, eight (24%) between 30-39 years of age, and four (12%) between 40-49 years of age. In addition, four educators (12%) self-identified as non-binary, 24 (73%) as female, and five (15%) as male. Lastly, the majority of the educators identified as White ($n = 22$, 67%), seven (21%) as Asian/Pacific Islander, two (6%) as More than one Race, one (3%) as Black, and one (3%) as American Indian.

Data Source

The general purpose of the PD cycle was to shift educators' growth in supporting failure moments during making-centered learning environments. Workshop 1 – Build and Define – was to reflect upon personal experiences of failure and develop a collective-focused working definition of failure through a making activity and discussion prompts. Example activities included a version of 'Would you rather...?' (e.g., would you rather experience 10 small failures or one huge failure?), making paper hats with different levels of guidance, and discussing direct quotes of what kids say about failure (Simpson et al., 2018). Workshop 2 – Engage and Plan – was to consider failure from the perspective of youth, particularly within the making activity that would be the focus of the educator's video reflection. This workshop was also used to brainstorm ways to respond to youth's failure moments during the making activity, as well as a focus on effective and non-effective language.

Following Workshop 2, educators videotaped at least one hour of their interactions with youth during the making activity. They then watched and reflected on their videos with a focus

on ways in which they responded and/or addressed youth's failures. They selected 1-2 clips that were not more than 3 minutes in length to share with their peers during Workshops 3 or 4 – Reflect and Improve. The focus of these workshops was for educators to share their video clips with their peers with the goal of reflecting upon their pedagogical failure moves as situated within the video clip, and to develop goals for improvement. For two sites, these workshops were structured as a one-on-one learning environment. Example questions that guided the Reflect and Improve workshops include (a) What feedback are you looking for in this clip?; (b) What did you do that you thought was effective (or ineffective)?; (c) Let's open up the discussion for suggestions on how to approach this situation.; and (d) Create an action item, something that you would like to take away and try out as you're facilitating in the future. Readers are encouraged to visit the project website – <https://bit.ly/3EDq51I> – for how the learning environment around the PD cycle was structured to meet the logistics and mission of each partnering museum sites.

Museum sites were asked to video recording their PD workshops to share with the research team. The number and length of video recordings per museum site can be found in Table 1. As seen in Table 1, the number and length of recordings varied per site. These were first transcribed using otter.ai, an automatic transcription service. A member of the research team then cleaned up the entire otter.ai transcriptions by focusing on accuracy of language.

Table 1

Video recordings collected per museum site

Pseudonym of Museum Site	PD1	PD2	PD3	PD4
Innovator (Year 2)	32:32		1:37:38	1:10:37
New England Museum of Science (Year 2)		0:18:54	0:39:24	0:36:24

Aweseum (Year 1)			1:28:08	
Aweseum (Year 2)	1:27:35	2:42:11	2:02:43	1:23:35
STEM Collaborative (Year 1)	0:40:00	1:55:37	0:48:42	0:39:11
STEM Collaborative (Year 2)		1:33:51	0:49:26	0:56:52
Art & Culture Institute (Year 1)		0:55:59	43:23	
Imaginary (Year 1)			0:29:35	
Imaginary (Year 2)			0:09:08	

Note. hours:minutes:seconds. PD represents professional development. The vertical line between PD2 and PD3 indicates video recording and video selection.

Data Analysis

In vivo coding was utilized to begin content analysis of the video transcriptions (Saldaña, 2012). In vivo coding, or verbatim coding, involved using direct quotes from educators to name and identify codes that attended to educators' failure pedagogical mindsets. For example, the direct quote was highlighted as it exemplified an effective response to youth when they experience a failure moment – "Like by throwing out a silly option, you can give them a tiny success moment to build on." The in vivo coding was "tiny success" as the goal of the educator's response was for the youth to experience success through failure. As another example, the direct quote, "one of the action steps I would like to take is like, stopping periodically to check in" was coded as "action steps" as the educator developed a next step in their growth through sharing and reflecting on their video clip with their peers. We grouped and regrouped codes into categories (see Online Resource 2 for codebook). For example, codes such as "time as a factor," "whether it's Tuesday or Friday," and "had enough time" were eventually categorized under "failure as

context dependent” to broadly indicate how educators described failure moments as shaped by various environmental factors, including time.

In general, we did not compare frequencies as this would have been similar to comparing apples to oranges as each museum site had flexibility in what was discussed within each workshop. Rather, we considered and discussed shifts in frequencies of categories between professional development prior to video recording and professional development grounded in video sharing. These shifts informed broader patterns of meaning in relation to failure pedagogical mindsets across the dataset; patterns situated and contextualized within the researchers ongoing collaboration with museum institutions in utilizing the professional development cycle to shift informal educators’ beliefs about failure and pedagogical practices within their professional role (Braun & Clarke, 2020; Trainor & Bundon, 2021). As noted by Braun and Clarke (2020), “researcher subjectivity is conceptualised as a *resource* for knowledge production, which inevitably sculpts the knowledge produced, rather than a must-be-contained threat to credibility” (p. 7-8, italics in original).

Findings

Study 1

Interviews with the 15 educators demonstrated the ways in which their conceptions of what failure can offer for learning can complement and also challenge their instructional practices. Pseudonyms are used when identifying participants. First, we noted how the majority of educators framed the learning potential of failing as directly tied to children’s binary reaction to failure: (a) with persistence, which would allow for learning and eventual success (“I don’t see it as failure. I see it as an opportunity for improvement.”), or (b) with negative emotions, which would derail any potential learning (“They just kind of shut down. Like I said, they just feel

really overwhelmed.”). Further, some educators framed learners’ reactions as an in-the-moment choice (“I think the negative outcomes are usually if *they choose to* shut down and give up”) while others framed it as a more stable trait in the short term (“There are some *kids who come in*, and one little thing goes wrong, and they’re pouting in the corner.”). As such, the educators’ instructional strategies – including modeling failure reactions, posing questions during failure moments, and planning teaching to avoid unnecessary failure – aimed to either promote persistence or avoid opportunities for negative emotions.

Second, when discussing their educational context and educational philosophy, educators named several challenges with their environment that led to a mis-match of their beliefs and ability to successfully utilize instructional strategies to support learners' failures. This finding looked at the interplay between their espoused beliefs and what they felt they were effective in achieving based on their organizational environment. Particularly for the museum educators, the desire to support student-directed projects and problem solving came into tension with the reality of limited educator-student contact time and the perception of parental expectations (e.g. educational, productive) for a paid summer camp program. These educators expressed pressure to have each student end the week with a “successful” creation. As Kylie, a museum educator, reflected, “it’s the students who don’t have time to finish or don’t have time to work their way to successful completion...they can be very disappointed I guess, with the camp or product or process.” Implicit in this educator’s quote is the uncertainty of impact from an “unsuccessful,” and thus disappointing creation. As a result, educators worried that learners would disengage from future making activities (re-entrenching negative associations with failure) or not attend future camps, workshops, or afterschool programs (which would have negative financial

implications for the institution). Thus, fully embracing failure as a pedagogical ideal was risky in light of their organizational context.

Finally, one outlier among the 15 educators shifted our own thinking about self-ownership of failures in a way that expanded our understanding of what was emerging as an “educator-focused failure moment.” One museum educator, Patrick, shared how he equated his own failures to his learners’ failures. While this was not an explicit question in our interview protocol, it is notable that there was little discussion of how an educator may feel as if *they* failed by not supporting learners through failures. When reflecting on the goals for his learners and the educational environment, Patrick stated: “As a teacher, failure also means running out of time...I haven’t structured things correctly if we’ve run out of time.” This educators’ failure mindset was always in relation to what the learner’s goals were. His responses prompted the code of “push students to own their learning,” which stemmed from discussion about student agency in the making process. Patrick stated, “The other thing I realized though is that part of why agency is really important is because something may look like crap to me, the kid is really happy with it. And it’s really important for me to shut the hell up in that moment.” While the dominant binary vision of failure placed responsibility for reaction to failure in the hands of learners, this educator noted his own role, his own self-failures, in constructing a particular made creation as “successful” or “unsuccessful”. As such, this educator reflected a relational thinking, specifically youth experiences of failure in making as intertwined with him experiencing failure in teaching, instead of centering failure on binary youth reactions.

Study 2

The results from Study 1 described educators’ failure pedagogical mindsets as either tied to a binary of success or failure, limited by institutional constraints, and with the exception of

one out of fifteen participating educators, absent of relational thinking between self- and youth-failures. In this section, we present three ways in which museum educators' failure pedagogical mindsets *shifted* through participating in a video-based PD cycle regarding failure moments. To note, we use the word shift, as opposed to learn, as the learning environment of the PD cycle was a foundational experience towards continuous reflection and potential transformation of museum educators' behaviors and failure pedagogical mindsets. We emphasize our findings through including exemplary direct quotes from participants. Pseudonyms are also used to maintain anonymity of participants.

Shifts in Failure Mindset

First, educators reflected more on self-failures as educators (e.g., “more of my failing”) within sharing and reflecting upon their video clips in Workshops 3 and 4 than discussed in Workshops 1 and 2. Consider the following quote by Alexa (Imaginary), “my own failure was I used the shoelace reference in the setup...they don't know how to tie their shoes yet.” Here, the failure was framed within the instructions provided, while in other instances, educators highlighted their instructional approaches as failure moments. “I used a different tone with her compared to the other campers. Just because she would always ask the same questions over and over” (Aurora, Aweseum). As another example, Nori (STEM Collaborative) stated the following: “I don't necessarily give enough time for people to figure it out on their own.” As implied in these examples, self-failures as professionals were void of youths' failure moments but in relation to their interactions with youths. Further, museum educators reflected less on environmentally-focused failures within the sharing and reflecting upon their video clips. Further, there was a shift in the external factor considered. Initially, educators described failure moments as being informed by time and learner differences. Through sharing and watching

video clips, educators less often talked about time and learner differences but focused on the material provided within the making-centered activity that led to failure moments. For instance, Rosalyn (New England Museum of Science) discussed failure as “kid dependent...some kids won’t be able to build the gearbox without us” in the PD prior to video recording. During PD4, Rosalyn focused on the material as it was a visible factor. “It was the materials themselves that they just didn't know how to manipulate them, but they knew what they wanted to do with it.”

Second, the utilization of video clips supported educators’ in making the transition from youth-focused failure moments as something abstract – “Like they can try their best 100% into it. And if those two pieces of tech just aren't connected right, it's never gonna work. It really has nothing to do with their amount of trying” (Myra, Aweseum) – to something grounded and intertwined in their interactions with youth as either effective or ineffective (i.e., relational). For instance, Myla (STEM Collaborative) reflected upon a moment in which a group’s building was not stable enough to withstand an earthquake. As stated by Myla, this was an effective clip because “I asked them questions about what happened.” Therefore, while the clip was a moment in which youth experienced failure, the video supported Myla in considering her response to the failure moment. As another example, Sonya (STEM Collaborative) picked a clip in which a child consistently struggled to use their constructed catapult to launch a ball into one of the platforms on a testing “rig.” Again, the focus of this clip shifted to one focused on her general responses to the child’s failure moment as “not being specific enough”. Sonya stated, “...because encouraging them to keep trying isn't a bad thing. But it doesn't necessarily tell them how to keep trying to hopefully be more successful.”

Additions to Failure Pedagogical Toolkit

Third, educators learned different ways to experiment with the same idea, namely that youth need to leave with a positive and successful experience and prototype. In other words, educators added failure pedagogical “success” moves to their toolkit; namely, supporting youth in meeting the goal/expectation set by self and/or others or to diminish the chances for failure to occur. In Workshops 1 and 2, approaches to youths’ failures were framed as turning any potential negative experience into a positive and successful experience. As stated by Eileen (Innovator), “removing the negative connotation from failure is also something that we strive for.” Similarly, “I’m really good at shutting that down and trying to flip to be more positive” (Sonya, STEM Collaborative). This transition was through instructional approaches and responses to youths’ failures such as collaboration (e.g., “working together toward getting at a solution”), posing questions (e.g., “what did you notice?”); modeling and providing exemplars (e.g., “And sometimes I purposefully make my stuff unstable to show them that like, Oh, mine didn't work”), and normalizing failure as part of the making-centered environment (e.g., “We make it a point at the beginning to say is it okay if what we're building doesn't work out the first time.”).

In Workshops 3 and 4, approaches to youths’ failures continued to be framed as turning any potential negative experience into a positive and successful experience. Unlike Workshops 1 and 2, this occurred through educators collectively reflecting on the video clips shared with one another; through reflecting on what they would do similarly or differently, as well as through providing suggestions to their peers. We provide one example to highlight this. Stacey (STEM Collaboration) picked a less effective clip for her response to a group of learners brainstorming on how to change their roller coaster structure to keep a marble from rolling off a track and

across the floor. Stacey's failure moment was in her response, not encouraging collaboration among learners. "I just told them to listen to her and do her idea. And then I walked away." Stacey reflected, "I would preferably either entertain a conversation for a minute, or maybe encouraged like, hey, why don't you discuss all your ideas and pick one." But to build off this, her peers provided feedback that reinforced the approach: (1) "I feel like that was a good exit moment. Sometimes letting them build their relationships on their own is okay." and (2) "I think it's okay to walk away temporarily, and then pass back by and see if we've made any progress." In general, suggestions were framed to support one another in terms of a failure positive pedagogical approach as opposed to providing alternatives to how Stacey could have responded in this identified failure moment.

While positive failure pedagogical approaches were reinforced, there were several nuances or shifts in such approaches to highlight. One being a shift in how museum educators perceived their professional role from facilitating youth's failure moments to stepping back and providing youth more opportunities to make their own decisions when experiencing failure moments (i.e., agency). For example, when asked what advice he would give himself, Reggie (Imaginary) stated, "do let them fail and let them work it out on their own and only come in and help when it feels like they have no other options." Another shift was specificity in language used by educators from general praise/feedback to specific praise/feedback. Alicia (STEM Collaborative), picked a failure moment in which two children's device did not launch the ball up," but backwards. As she reflected on this video, she shared the following.

I think the thing that I would change, that I could identify just in these clips specifically, is just offering more specific feedback. I would try to encourage them to have specific things they could work on rather than be like, "Oh, too bad" or "Oh, you were close."

One last shift was a focus on lesson plan/program level strategies and supports towards “success.” For instance, Suzanne (Aweseum) picked out an educator-focused failure moment in which she noted a “big fail on teaching [a child] how to rip tape. I just didn't follow through enough.” This funneled into a conversation on the struggles for young children to tear pieces of tape from a roll and how to support this through similar actions such as ripping paper or using a zipper. As a collective action item, they determined to consider “the materials that we put out, what tape does stick and doesn't stick to all the tape options that we have available to use.”

Discussion

In this paper, we add to the scant literature base on learning from failures with a particular focus on understanding educators’ shifting mindsets in making-centered learning environments. In looking across the two studies, three themes emerged through our ongoing dialogue and interpretative lens on the findings, particularly as researchers that worked closely with the participants and shared common experiences and tensions around our responses and interactions with youth-focused and educator-focused failure moments (e.g., Simpson & Feyereabend, 2022). As such, we argue for the inclusion of a reflective learning environment, particularly a video-based reflection environment, for educators to develop, refine, and/or enhance their failure pedagogical mindsets. The PD cycle in Study 2 afforded educators an opportunity to talk about failure moments with others and foster collective reflection and development, which is not well situated in prior scholarship (Lutovac, 2019). In emotionally-charged concepts such as failure (e.g., Lottero-Perdue & Parry, 2017), our research suggests that examination of ones’ own relationship to failure as an educator is important and seeing ones’ own failure pedagogical mindset in action may help to shift such a mindset into a more complex and relational realm.

Theme 1: Seeing Failure Pedagogical Mindset in Action

Across both studies, there were instances in which educators failed to consider the complexity of their own self-failures as professionals in relation to youths' failure moments. This was unexpected as prior scholarship notes how educators recognize this complex relationship between professional and youth failure moments (e.g., Lutovac & Flores, 2021). Within the PD cycle, particularly through the sharing and discussing of video clips, educators were comfortable with naming and sharing self-failure moments as an educator, which may serve as opportunities for professional growth and development (Lutovac & Flores, 2021; Starrett et al., 2023). Even when educators selected clips that focused on youths' failure moments, the conversation was grounded in their response or instructional practice that were effective or not effective in supporting youth in persisting to a successful prototype. This was a shift from an abstract sense of youth-failure moments to one that is relational (i.e., youth-educator failure moments). We hypothesize that video reflection with a focus of failure moments prompted a response of self-failure because educators saw the disconnect between their values and their pedagogical practices, which directed their failure pedagogical mindsets to self. Therefore, there is value of seeing one's own failure pedagogical mindset in action.

We also caution that a focus on self-failures could also be associated with educators understanding failure as *being* a failure (Lutovac & Flores, 2021). Identifying self as a failure has implications for their identity development and may negatively shape their pedagogical approaches, work engagement, and students overall experience as learners (Fronozo et al., 2022; Muenks & Yan, 2022; Nalipay et al., 2021). Additional research should be conducted to understand the complexity in naming and examining moments of failure as educators as tied to identity development and perceived sense of efficacy. Theoretically, there is also a possibility to

consider how beliefs about failure interact and/or build upon educators' instructional moves, particularly within organizational structures and expectations that may lead to tensions between the two. This would advance research that suggest that one's beliefs about failure shape or inform their instructional practices (e.g., Lutovac, 2019).

Theme 2: Transforming Failure through Pedagogical “Success” Moves

Educators in both studies described their use of failure positive pedagogical approaches to support learners “success,” which are similar to prior scholarship such as asking questions and modeling failure reactions (e.g., Ryoo et al., 2015; Warshauer, 2015). Through the PD cycle, educators provided one another with instructional approaches that reinforced the idea of promoting youth persistence and success through failure moments. This may have implications for youths' failure mindset as one that is malleable and an opportunity for growth as prior scholarship has shown how adults' actions and behaviors in response to failure moments shape those of youth (e.g., Haimovitz & Dweck, 2016; Muenks & Yan, 2022). We further hypothesize that this theme is associated with educators competing priorities in their roles and/or having less time to develop relationships with learners from which to repair and recover from failure. These tensions can lead to a need to assist learners in finding “success” or have a satisfying experience. This is particularly evident in the convergent finding of tensions around educator-learner contact time and acceptability of failure (i.e. failure is ok at the beginning of week but not at end) within organizational structures. Such failure-positive pedagogical practices within making-centered environments seem non-risky and antithetical to this idea that failure is something to embrace as part of the process (Martin, 2015) but akin to other learning environments (e.g., classrooms) in which there is pressure to have a “successful” project.

On the other hand, this finding may also reinforce the idea that success will always happen, which is a misnomer, particularly in science, technology, engineering, and mathematics (STEM) industries (Liu & Zhang, 2022; Simpson & Maltese, 2017; Ubani & Ononuju, 2013). Based on the interview of over 100 professionals in STEM, Simpson and Maltese (2017) suggested exposing youth to experiences with failures as the professionals in their study express how failure experiences shaped their career trajectory in STEM. We also question how not acknowledging youths' negative emotional state and negative reactions may not be an effective pedagogical approach. This is an area of focus for future research, particularly in examining the implications of this approach for youths' experiences. A self-study approach might be a productive methodology for contributing to a theory of practice for educators (e.g., Dinkleman, 2003).

Theme 3: Making Space for Students to Manage Failures

As noted by Patrick in Study 1, notions of failure should be considered through the eyes of youth as opposed to educators' notion of failure and ideas of a successful or unsuccessful prototype. In Study 2, video-based reflections shifted how a few educators perceived their role in facilitating youth's experiences with failure during making-centered learning environment, from one of facilitating success (i.e., stepping in) to providing space and time for youth to make their own decisions regarding how to respond to failure moments (i.e., stepping back). This shift further highlights the potential value in sharing and discussing video clips within a shared and collaborative professional space. This may have implications for the culture of learned helplessness and feeling of being "helpless" prevalent in various learning environments (e.g., Blikstein & Worley, 2017); yet, there is a delicate balance as persistence in "helpless" situations may lead to feelings of disappointment (Lench & Levine, 2008) and shame (McGregor & Elliot,

2005). We also hypothesize that as educators became more comfortable with youths' failures, their beliefs may shift toward failure and failure reactions as expressions of youth agency instead of needing educator intervention.

Implications for Practice

The findings across both studies also have implications for practice. First, naming tensions and failures within making-centered learning environments may help further support educators' understanding of their use of specific pedagogical practices, which in turn might suggest incongruence between their professed mindset and their enactment of instructional practices. This can be supported through an additional feedback loop to examine the environment/activities offered in making-centered learning environments and the ways in which they are (or are not) designed to support genuine struggle and failure. This approach furthers the idea that learning environments are always dynamic systems that can be changed.

Second, self-reflection, in this case through video, was an important part of educators' reflection of failure moments that were not necessarily disclosed or expressed in Study 1, and mirrored the type of reflection we encourage in youths' experiences with failure. Therefore, we encourage the utilization of video-based reflections to support educators' growth and development through experiences of self-failures and responses to youths' failures. As such, asking educators to articulate and examine their beliefs regarding failure can/should be a part of professional practice. Addressing the struggle inherent in learning as a valuable and integral part of professional growth and development benefits educators' congruence between mindsets and practice, and theoretically, learners' experience through failure moments.

Conclusion

The research highlighted in this paper signals the importance of understanding educators' view of their role in facilitating failure for their learners and the implications that has on supporting youth through failure moments in making-centered learning environments. Results highlighted how educators believed that failure (and its synonyms) can facilitate learning and that their pedagogical approaches should include opportunities to foster success and learning from failure experiences. This focus may mask the idea that failure can happen in making-centered and STEM-related learning environments. Further, educators' failure mindsets were often not aligned well with their pedagogical practices. And while video-based reflection supported educators in focusing in on their own pedagogical failures, this may or may not have been considered within educator-youth interactions.

References

- Birks, M., Chapman, Y., & Francis, K. (2008). Memoing in qualitative research: Probing data and processes. *Journal of Research in Nursing*, 13(1), 68-75.
<https://doi.org/10.1177/1744987107081254>
- Blikstein, P., & Worsley, M. (2017). Children are not hackers: Building a culture of powerful ideas, deep learning, and equity in the maker movement. In K. Peppler, E. R. Halverson, & Y. B. Kafai (Eds.), *Makeology: Makerspaces as learning environments* (pp. 64–79). New York, NY: Routledge.
- Booth, C., & Segon, M. (2009). A leadership and management practice development model. *International Review of Business Research Papers*, 5(2), 19-41.
- Borko, H., Jacobs, J., Eiteljorg, E., & Pittman, M. E. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching and Teacher Education*, 24(2), 417-436. <https://doi.org/10.1016/j.tate.2006.11.012>
- Borko, H., Jacobs, J., Koellner, K., & Swackhamer, L. E. (2015). *Mathematics professional development: Improving teaching using the problem-solving cycle and leadership preparation models*. Teachers College Press.
- Braun, V., & Clarke, V. (2020). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*. [Advanced online publication].
<https://doi.org/10.1080/14780887.2020.1769238>
- Dinkelman, T. (2003). Self-study in teacher education: A means and ends tool for promoting reflective teaching. *Journal of Teacher Education*, 54(1), 6-18.
<https://doi.org/10.1177/0022487102238654>
- Dweck, C. S. (2006). *Mindset*. Random House.

- Dweck, C. S., & Yeager, D. S. (2020). A growth mindset about intelligence. In G. M. Walton & A. J. Crum (Eds.), *Handbook of wise interventions: How social psychology can help people change*. Guilford Publications.
- Frondozo, C. E., King, R. B., Nalipay, M. J. N., & Mordeno, I. G. (2020). Mindsets matter for teachers, too: Growth mindset about teaching ability predicts teachers' enjoyment and engagement. *Current Psychology*, 41, 5030-5033. <https://doi.org/10.1007/s12144-020-01008-4>
- Grabman, R., Stol, T., McNamara, A., & Brahms, L. (2019). Creating and sustaining a culture of reflective practice: Professional development by and for museum-based maker educators. *Journal of Museum Education*, 44(2), 155-167. <https://doi.org/10.1080/10598650.2019.1596735>
- Haimovitz, K., & Dweck, C. S. (2016). What predicts children's fixed and growth intelligence mind-sets? Not their parents' views of intelligence but their parents' views of failure. *Psychological science*, 27(6), 859-869. <https://doi.org/10.1177/0956797616639727>
- Haimovitz, K., & Dweck, C. S. (2017). The origins of children's growth and fixed mindsets: New research and a new proposal. *Child Development*, 88(6), 1849-1859. <https://doi.org/10.1111/cdev.12955>
- Helsing, D. (2007). Regarding uncertainty in teachers and teaching. *Teaching and Teacher Education*, 23(8), 1317-1333. <https://doi.org/10.1016/j.tate.2006.06.007>
- Heyd-Metzuyanim, E. (2015). Vicious cycles of identifying and mathematizing: A case study of the development of mathematical failure. *Journal of the Learning Sciences*, 24(4), 504-549. <https://doi.org/10.1080/10508406.2014.999270>

- Kraker-Pauw, E., Van Wesel, F., Krabbendam, L., & Van Atteveldt, N. (2017). Teacher mindsets concerning the malleability of intelligence and the appraisal of achievement in the context of feedback. *Frontiers in Psychology*, 8, Article 1594.
<https://doi.org/10.3389/fpsyg.2017.01594>
- Lench, H. C., & Levine, L. J. (2008). Goals and responses to failure: Knowing when to hold them and when to fold them. *Motivation and Emotion*, 32(2), 127–140.
<https://doi.org/10.1007/s11031-008-9085-1>
- Liu, Z., & Zhang, L. (2020). A review of failure modes, condition monitoring and fault diagnosis methods for large-scale wind turbine bearings. *Measurement*, 149, Article 107002.
<https://doi.org/10.1016/j.measurement.2019.107002>
- Lock, J., Gill, D., Kennedy, T., Piper, S., & Powell, A. (2020). Fostering learning through making: perspectives from the International Maker Education Network. *International Journal of E-Learning & Distance Education*, 35(1), Article 1160.
- Lottero-Perdue, P. S., & Parry, E. A. (2017). Elementary teachers' reflections on design failures and use of fail words after teaching engineering for two years. *Journal of Pre-College Engineering Education Research (J-PEER)*, 7(1), Article 1. <https://doi.org/10.7771/2157-9288.1160>
- Lutovac, S. (2019). Pre-service mathematics teachers' narrated failure: Stories of resilience. *International Journal of Educational Research*, 98, 237-244.
<https://doi.org/10.1016/j.ijer.2019.09.006>
- Lutovac, S. (2020). How failure shapes teacher identities: Pre-service elementary school and mathematics teachers' narrated possible selves. *Teaching and Teacher Education*, 94, Article 103120. <https://doi.org/10.1016/j.tate.2020.103120>

- Lutovac, S., & Assuncao Flores, M. (2021). ‘Those who fail should not be teachers’: Pre-service teachers’ understandings of failure and teacher identity development. *Journal of Education for Teaching*, 47(3), 379-394. <https://doi.org/10.1080/02607476.2021.1891833>
- Maltese, A., Simpson, A., & Anderson, A. (2018). Failing to learn: The impact of failures during making activities. *Thinking Skills and Creativity*, 30, 116-124.
<https://doi.org/10.1016/j.tsc.2018.01.003>
- Martin, L. (2015). The promise of the maker movement for education. *Journal of Pre-College Engineering Education Research (J-PEER)*, 5(1), Article 4. <https://doi.org/10.7771/2157-9288.1099>
- McGregor, H. A., & Elliot, A. J. (2005). The shame of failure: Examining the link between fear of failure and shame. *Personality and Social Psychology Bulletin*, 31(2), 218–231.
<https://doi.org/10.1177/0146167204271420>.
- Mintchik, N., Ramamoorti, S., & Gramling, A. A. (2021). Mindsets as an enhancement of 21st century accounting education. *Issues in Accounting Education*, 36(4), 87-118.
<https://doi.org/10.2308/ISSUES-19-066>
- Muenks, K., & Yan, V. X. (2022). University STEM instructors with stronger failure-as-debilitating mindsets are perceived to engage in fewer mastery-oriented teaching Practices by their students: An exploratory study. *Social Psychology of Education*, 25(5), 1205-1219. <https://doi.org/10.1007/s11218-022-09718-2>
- Nalipay, M. J. N., King, R. B., Mordeno, I. G., Chai, C. S., & Jong, M. S. Y. (2021). Teachers with a growth mindset are motivated and engaged: the relationships among mindsets, motivation, and engagement in teaching. *Social Psychology of Education*, 24, 1663-1684.
<https://doi.org/10.1007/s11218-021-09661-8>

- National Research Council. (2009). *Learning Science in informal environments: People, places, and pursuits*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/12190>
- Ryoo, J. J., Bulalacao, N., Kekelis, L., McLeod, E., & Henriquez, B. (2015). Tinkering with “failure”: Equity, learning, and the iterative design process. *FabLearn 2015 Conference at Stanford University*. <https://doi.org/10.1348/000709908X398106>
- Saldaña, J. (2012). *The coding manual for qualitative researchers* (2nd ed.). Sage Publications.
- San Juan, A., & Murai, Y. (2022). Turning frustration into learning opportunities during maker activities: A Review of Literature. *International Journal of Child-Computer Interaction*, 33, 100519. <https://doi.org/10.1016/j.ijcci.2022.100519>
- Sherin, M. G. (2004). New perspectives on the role of video in teacher education. In J. Brophy (Ed.), *Using Video in Teacher Education* (pp. 1-27). Elsevier Science.
- Shoshani, A. (2021). Growth mindset in the maths classroom: A key to teachers’ well-being and effectiveness. *Teachers and Teaching*, 27(8), 730-752. <https://doi.org/10.1080/13540602.2021.2007370>
- Simpson, A., Anderson, A., & Maltese, A. V. (2019). Caught on camera: Youth and educators’ noticing of and responding to failure within making contexts. *Journal of Science Education and Technology*, 28(5), 480-492. <https://doi.org/10.1007/s10956-019-09780-0>
- Simpson, A., Anderson, A., Maltese, A. V., & Goeke, M. (2018). *"I'm going to fail": How youth interpret failure across contextual boundaries*. In J. Kay & R. Luckin (Eds.), *Proceedings of the 13th International Conference of the Learning Science* (Vol. 2, pp. 981-984). London, United Kingdom: University College London.

- Simpson, A., & Feyerabend, M. (2022). Tug-of-war: The pull of formal institutional practices and structures and the desire for personal change. *International Journal of Science and Mathematics Education*, 20, 149-168. <https://doi.org/10.1007/s10763-020-10139-w>
- Simpson, A., & Maltese, A. V. (2017). "Failure is a major component of learning anything.": The role of failure in the career development of STEM professionals. *Journal of Science and Technology Education*, 26(2), 223-237. <https://doi.org/10.1007/s10956-016-9674-9>
- Starrett, E., Firetto, C. M., & Jordan, M. E. (2022). Navigating sources of teacher uncertainty: exploring teachers' collaborative discourse when learning a new instructional approach. *Classroom Discourse*, 14(1), 45-68. <https://doi.org/10.1080/19463014.2021.2013266>
- Sudzina, M. R., & Knowles, J. G. (1993). Personal, professional and contextual circumstances of student teachers who "fail": Setting a course for understanding failure in teacher education. *Journal of Teacher Education*, 44(4), 254-262.
- Trainor, L. R., & Bundon, A. (2021). Developing the craft: reflexive accounts of doing reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 13(5), 705-726. <https://doi.org/10.1080/2159676X.2020.1840423>
- Tran, L. U., Gupta, P., & Bader, D. (2019). Redefining professional learning for museum education. *Journal of Museum Education*, 44(2), 135-146. <https://doi.org/10.1080/10598650.2019.1586192>
- Ubani, E. C., & Ononuju, C. N. (2013). A study of failure and abandonment of public sector-driven civil engineering projects in Nigeria: An empirical review. *American Journal of Scientific and Industrial Research*, 4(1), 75-82.
- Vossoughi, S., & Bevan, B. (2014). *Making and tinkering: a review of the literature*. National Research Council.

- Warshauer, H. K. (2015). Productive struggle in middle school mathematics classrooms. *Journal of Mathematics Teacher Education*, 18(4), 375–400. <https://doi.org/10.1007/s10857-014-9286-3>
- Yeager, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. *Educational Psychologist*, 47(4), 302-314. <https://doi.org/10.1080/00461520.2012.722805>
- Zarrinabadi, N., & Afsharmehr, E. (2022). Teachers' mindsets about L2 learning: Exploring the influences on pedagogical practices. *RELC Journal*. [Advanced online publication]. <https://doi.org/10.1177/00336882211067049>
- Zimmerman, A., Eubank, C., Goldberg, E., Lahr, E., Sneed, S., & Welch, S. (2022). Living truthfully in classroom circumstances: Responding to moments of uncertainty in teaching and acting. *Curriculum & Teaching Dialogue*, 24(1-2), 155-172.