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USING IMPROVISATIONAL TECHNIQUE AND EXPERIMENTIAL LEARNING IN THE STEM/STEAM/STREAM CLASSROOM

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Abstract

Researchers from the Northern Gulf Institute and the Department of Communication at Mississippi State University have a long-running partnership in creating STEM/STEAM/STREAM experiential education opportunities for K-12 students by combining (theatre) arts-integrated lessons into not only earth, atmospheric, and oceanographic science classrooms but in our experiential outdoor environmental programs, in a lively, immersive and interactive way through the application of improvisational (Improv) techniques, and theatre arts.

By applying these methods, the authors give the students an atypical outlet of expression in what has traditionally been a teacher-centered and often one-sided classroom learning experience and shifted into a combination of content-focused and interactive/participative teaching. These methods aim to enhance student learning and retention through improved psychological and social interactions and create a memorable and enjoyable classroom learning experience with the hope of stimulating student interest in STEM/STEAM/STREAM fields that will benefit society through improved education and workforce development outcomes for the future.

Introduction

STEM classes (science, technology, engineering, and mathematics) are essential in the American educational system for several reasons. They provide students with the knowledge and skills necessary to succeed in a rapidly changing and technologically advanced society. STEM education helps students develop critical thinking and problem-solving skills essential for success in any field. Additionally, many of the fastest-growing and highest-paying jobs in the United States are in STEM fields, so studying STEM can lead to career opportunities with good earning potential. Furthermore, STEM education is essential for the future of the United States. It will help ensure that the country remains competitive in the global economy and continues to advance in areas such as science and technology.

The concept of STEAM (science, technology, engineering, arts, and mathematics) education in the American education system has been gaining momentum in recent years. However, the exact origins of the term "STEAM" are unclear, and it has been used in various contexts over time. Some educators and organizations began using the concept as early as the 1980s, but it became widespread in the 2000s. In 2011, the Rhode Island School of Design (RISD) and the National Science Foundation (NSF) jointly organized a conference, "STEM to STEAM," to move the conversation from science, technology, engineering, and math (STEM) to science, technology, engineering, arts, and math (STEAM) education. The conference marked the official launch of the STEAM movement, and since then, many schools and educators have begun incorporating the arts into their STEM programs.

The concept of STREAM (science, technology, recreation, engineering, arts, and mathematics), as introduced by Yoh and others (2021), adds recreation to the traditional STEM/STEAM matrix to enhance teaching methods by making the learning activity “experiential, interactive, and fun” This is a relatively new concept in the literature but fits well within the structure of Improvisation and its application in the classroom. Initial studies on the topic indicate that adding recreation to STEM/STEAM not only enhances students' psychological health, cognitive function, and even potentially physical fitness depending on the application but helps the student retain more of the learned material through association with an enjoyable experience.

Incorporating the arts into STEM classes and creating STEAM programs in the American education system is essential for several reasons that, include:

1. Creativity and Innovation: The arts encourage creativity, which is essential for innovation in STEM fields. Combining the skills and STEM allows students to think outside the box and approach problems uniquely.

2. Whole-brain thinking: The arts and STEM subjects use different parts of the brain, and by combining them, students can develop "whole-brain" thinking, which will help them to think more critically, solve problems more effectively, and make better decisions.

3. Career readiness: Many jobs in the 21st century require a combination of STEM and art skills. By providing students with STEAM education, schools prepare them for a broader range of careers, including those in engineering, design, gaming, and technology.

4. Engagement and Interest: Some students may find traditional STEM classes dry or uninteresting, but incorporating arts could make the subject more accessible and engaging.

5. Cultural and Social Impact: The arts and STEM are powerful tools for understanding and shaping the world around us. By combining them, students can better understand STEM advancements' cultural and social implications.

6. Humanities and Ethics: The arts can provide the context and perspective to explore the ethical and social implications of new technologies and help mold how individuals and society think (critically) concerning the consequences of new technologies, and allow participants to make informed decisions about using these technologies.

This paper explores the potential of utilizing improvisation methods to teach STEM courses. Improvisation is a method of teaching and learning in which students are encouraged to think creatively, solve problems spontaneously, and develop interpersonal skills. Improvisation is a form of performance that incorporates theater, music, and dance elements. Improvisation has long been used in theater and other performing arts but is increasingly used in educational contexts. This paper will discuss the potential benefits of incorporating Improvisation into STEM courses and the challenges and considerations that must be considered when using Improvisation in the classroom.

Background

Recently, Improvisation has become increasingly popular in educational contexts. Improvisation can be used to teach a variety of skills, such as creative problem-solving, communication, teamwork, and leadership. Improv, or Improvisation, is a method of teaching and learning that emphasizes spontaneity, creativity, and critical thinking. It is often used in theater to entertain. It has no planning and does not rely on props or set pieces. Examples of well-known improv groups include Second City, The Groundlings, and Upright Citizens Brigade Theatre. Improvisation can yield transferrable skills to other fields, including STEM education. This methodology allows performers to create and develop spontaneous scenes and dialogues without prior preparation or planning. Improvisation has been used in theater, music, dance, and other performing arts for centuries. Improvisation is an essential skill for performers, allowing them to be creative and react quickly to environmental changes.

Generally accepted rules for Improvisation are explained as follows: Always agree with the scene partner. This rule is also known as "Say Yes." If someone says, “I see a purple elephant over there. The other person or persons in the scene should not deny it. They would agree and honor that choice and then add something which leads to the second rule of Improvisation, “say yes and…."

When working in Improvisation, partners build on each other. Referring to the first example, the dialogue may go something like this. " Yes, the elephant is lovely and so unusual. This zoo has some very rare animals." Those working on the improvisation exercise should be bold in contributing. For Improvisation to be effective, those involved should take on the responsibility to move the work forward (Fey, 2011) and (Mcknight & Scruggs, 2008).

The work should advance primarily through statements that add to the scene. Questions can burden the Improvisation on the person required to answer them (Fey, 2011). From the previous example, if someone said, "Why is that elephant purple?" instead of "Yes, the elephant is lovely and so unusual…" the burden follows on the person initializing the conversation.

Improv's final and most essential rule is that "there are no mistakes, only opportunities." For example, an improv performer is pantomiming and eating spaghetti. However, their partner in the scene says, "Wow, it looks like you are enjoying that plate of worms" The other partner could move forward by saying, "Yes, you know what they say about the early bird."

A simple and easy improvisation exercise that stimulates communication and teamwork is a game called, The Scream. Students make a large circle with their heads lowered and then raise their heads to a count of three, establish eye contact, and then scream, looking at that person. If they connect, they may pull out of the circle; if not, they continue playing the game until everyone is out. This game will evoke laughter from the participants as inhibitions are dropped to play the game.

Improv in Life

Using Improvisation as a teaching tool has a long history as a basis for everything a person does. In the grand reality, it is all improvised. As one engages with the world and with other people, so too does one act and react in real-time to unique circumstances. Small, everyday activities such as conversations, taking detours on the way to work, or deciding what

to order for lunch are nothing more than small-stakes Improvisation done without a second thought or need for justification.

Improvisation exercises follow this logic in the theatre classroom to improve how one engages in these small "real world" improvisational moments. Viola Spolin taught that a student honing these skills in a theatre setting would influence how they experience their world, even assigning “experiencing” as homework for an actor (Spolin, 1963). The actor following this process would take these stimuli and internalize their reactions to understand better the nature of instinct and its importance to how a person engages both in life and as an actor in rehearsal.

The statement best summarizes this teaching technique, "it is imperative to sharpen one's whole sensory equipment . . . This, then, broadens the student actor's ability to involve himself with his phenomenal world and more personally to experience it” (Spolin, 1963). Taking an active approach to examine their reactions and the improvisational nature of how they interact with the world has noticeable effects on how effectively they learn. Engaging with students from this angle improves their understanding of what Improvisation is and how it can be used to facilitate their learning.

Preferred Methodology

Problem-based learning (PBL) and role-play are teaching methods that involve active learning and real-world scenarios to help students better understand and apply scientific concepts and principles. However, they differ regarding the specific activities and skills they emphasize (Allen and others, 2011).

In PBL, students are presented with a real-world problem to solve, such as a problem related to environmental pollution. The focus is on using scientific knowledge and problem-solving skills to develop a plan to solve the problem. Students research the problem, identify potential sources of pollution, and develop a plan to reduce it. They also analyze the situation from a different perspective, research laws and regulations, and the impact of the problem on the environment. PBL can help students develop critical thinking and problem-solving skills and a deeper understanding of the subject matter.

In role-play, students take on different roles, such as scientists or engineers, and use Improvisation to simulate real-world scenarios. The focus is on understanding how other actors interact in the scenario, how different variables affect the outcome, and how the subject matter principles are applied. For example, in a biology class, students could take on the roles of different organisms and use Improvisation to explore how they interact in an ecosystem. This can help students understand the relationships between other organisms and their role in maintaining the ecosystem's balance. Role-playing can help students better understand the subject and improve communication and collaboration skills.

Both methods have their strengths and weaknesses, and the choice of which way to use them may depend on the specific learning objectives and the subject matter. PBL focuses on problem-solving and critical thinking, while role-playing focuses on understanding the interactions and the application of the subject matter. Both methods can be used together to supplement each other and enhance student learning.

Problem - Based – Learning in Improv and the Classroom

One way to use Improv in STEM classes is problem-based learning (PBL). PBL is a method of teaching that involves giving students a problem to solve rather than just providing them with information. Improv can be used to help students come up with creative solutions to the issue at hand. For example, in a physics class, students could be given a problem involving a specific physical phenomenon and then use improv techniques to brainstorm possible explanations (Allen and others, 2011).

Problem-based learning (PBL) is a method of teaching that involves giving students a problem to solve rather than just providing them with information. PBL can help students better understand and apply scientific concepts and principles in a science classroom by providing real-world problems requiring scientific thinking and problem-solving skills (Wood, 2003).

For example, in a biology class, students could be presented with a real-world problem, such as how to control an invasive species that is disrupting an ecosystem. Students would then be responsible for researching the issue and using scientific knowledge to devise a solution. They could examine the characteristics of the invasive species, the ecosystem, and potential solutions (Allen, 2003). They can use this knowledge to develop a plan to control the invasive species and evaluate the program's effectiveness.

In a chemistry class, students could be presented with a problem related to environmental pollution and be asked to develop a plan to reduce pollution in a specific area. Students would then be responsible for researching the issue and using their chemistry knowledge to identify

potential pollution sources and develop a plan to reduce them. They could also explore the laws, regulations, and impact of pollution on the environment.

In physics, students could be presented with a problem related to energy conservation, such as how to design a more energy-efficient building. Students would then use their knowledge of physics to analyze the energy use of the building and identify ways to reduce it. They could also research the different materials, technology, and design that can be used to improve energy efficiency. Recently even the scientists at CERN, the European Organization for Nuclear Research, have recognized and, in fact, even acknowledged the usefulness of Improvisation when they switched on the Large Hadron Collider. They valued the ability to think on their feet and the effectiveness in communication that Improv games can yield (Lyden, 2008).

In this manner, PBL can be a valuable tool in a science classroom as it can help students better understand and apply scientific concepts while developing critical thinking and problem-solving skills. PBL can also make the learning experience more engaging and relevant to real-world problems. However, it is essential to note that PBL should be carefully planned and executed by the teacher and incorporated into the curriculum to enhance the learning of the subject matter.

Role-Play in Improv and the Classroom

Another way to use Improv in STEM classes is through role-playing. In this method, students take on different roles, such as scientists or engineers, and use Improv to simulate real-world scenarios. This can help students better understand the material and develop critical thinking skills. For example, in a biology class, students could take on the roles of different

organisms and use Improv to explore how they interact in an ecosystem (Stokoe, 2014). Role-playing is a teaching method involving students taking on different roles, such as scientists or engineers, and using Improvisation to simulate real-world scenarios. Role-playing can help students understand and apply scientific concepts and principles in a science classroom (Wadensjö, 2014).

For example, in a biology class, students could take on the roles of different organisms and use Improvisation to explore how they interact in an ecosystem. This can help students understand the relationships between organisms and their role in maintaining the ecosystem's balance. In a chemistry class, students could take on the roles of different chemical elements and use Improvisation to explore how they interact with each other to form compounds. This can help students understand chemical reactions and the formation of compounds. In physics, students could take on the roles of different physical quantities and use Improvisation to explore how they interact with each other in different scenarios. This can help students understand the physical laws and how they apply them to real-world situations (Lillard, 2013).

Role-playing can also be used to simulate scientific experiments. For example, students could take on the roles of scientists and use Improvisation to design and conduct an investigation to test a specific hypothesis. This can help students understand the scientific method and the importance of experimental design.

Role-playing can be a valuable tool in a science classroom as it can help students better understand and apply scientific concepts while developing critical thinking and problem-solving skills. However, it is essential to note that role-playing should be carefully planned and

executed by the teacher and incorporated into the curriculum to enhance the learning of the subject matter.

Further Uses of Improv in the STEM/STEAM/STREAM Classroom

Incorporating Improv can also help students develop communication and teamwork skills essential in STEM fields. By working together to solve problems and complete tasks, students can learn how to communicate effectively with each other and work as a team. Improv, or Improvisation, can be valuable for helping students develop communication and teamwork skills. Improv exercises and games involve quick thinking, active listening, and effective communication, all essential for success in academic and professional settings (Gillian-Daniels and others, 2020).

As discussed earlier, Role Playing Exercises can involve students taking on different roles, such as scientists or engineers, and using Improvisation to simulate real-world scenarios. For example, in a science class, students could take on the parts of different organisms and use Improvisation to explore how they interact with each other in an ecosystem. This can help students understand the relationships between organisms and their role in maintaining the ecosystem's balance. Additionally, these exercises help students develop their communication and teamwork skills as they work together to create a believable and engaging scenario (McKnight & Scruggs, 2008).

Another way to use Improv in the classroom is through improv games, such as "Yes, and...". This game involves students taking turns adding to a story or scenario and starting each

sentence with "Yes, and...". This helps students build on each other's ideas, a critical teamwork skill. Improv games can also help students develop their communication skills by encouraging them to think on their feet and express their ideas clearly and effectively. Improv can also help students develop their public speaking and presentation skills. Improv exercises help students overcome their fear of public speaking and become more comfortable speaking in front of an audience (McKnight & Scruggs, 2008). This can be done by giving them different scenarios, such as providing a presentation about a scientific topic or giving a hypothetical interview for a job in a particular field. In this manner, Improv can be a valuable tool for helping students develop communication and teamwork skills. Improv exercises and games can help students build on each other's ideas, express themselves clearly and effectively, and overcome their fear of public speaking. Improv can also help students understand the subject matter and develop a deeper understanding of the interactions and the application of the subject matter.

Connections between Improv and Experiential Learning in the Classroom

Experiential learning is a teaching and learning approach that emphasizes direct experiences or hands-on activities as the primary source of education and knowledge acquisition (Dewey, 1897). It involves actively engaging in real-life experiences, reflecting on those experiences, and drawing meaning and insights from them. Experiential learning aims to develop practical skills, knowledge, and values in a meaningful and applicable way. This approach can be applied in various fields, including education, business, and personal development (Ballon and others, 2007).

Experiential learning can be effectively applied in STEM (science, technology, engineering, and mathematics) or STEAM (STEM plus art) classrooms to enhance students' understanding and engagement in these subjects. This approach allows students to engage in hands-on projects, design challenges, and problem-solving exercises related to real-world situations. This allows students to develop critical thinking and problem-solving skills and apply their knowledge in meaningful and applicable ways. Additionally, experiential learning in STEM/STEAM classrooms can increase students' interest and excitement for these subjects and foster their creativity and innovation. Examples of experiential learning activities in STEM/STEAM classrooms may include building prototypes, creating digital animations, conducting experiments, and designing and coding computer programs (Boggs and others, 2007).

Experiential learning and improvisation (Improv) can be closely tied together, as both approaches emphasize active engagement, collaboration, and adapting to new situations. Improv is a live theater where performers create scenes, characters, and dialogue on the spot, without a script. This requires them to think quickly, respond to their environment and fellow performers, and remain flexible and open to new possibilities. Similarly, experiential learning involves engaging in real-life experiences and adapting to new situations, often in a collaborative setting. By engaging in hands-on activities, students develop critical thinking, problem-solving, and creativity skills, also essential elements in Improv. Both experiential learning and Improv foster a growth mindset and encourage individuals to embrace uncertainty and new challenges with confidence and creativity. As such, they are incorporating elements of Improv into experiential learning activities can add a layer of engagement and creativity,

helping students to build skills in communication, collaboration, and adaptability (Silberman, 2007).

Conclusions

In summary, Improvisation can be a valuable tool in STEM education, as it can help students develop critical thinking, problem-solving, communication, and teamwork skills. It can be applied through problem-based learning and role-playing exercises. However, it is essential to note that the teacher should carefully plan and execute Improvisation in STEM education and incorporate it into the curriculum to enhance the learning of the subject matter (Allen and others, 2011).

Creativity is essential to innovation, as it allows individuals to generate new and unique ideas, concepts, and solutions to problems. The ability to think differently and develop novel ideas can lead to innovation. Creativity allows people to challenge the status quo and think beyond the boundaries of existing knowledge or solutions. It allows for experimentation and risk-taking, vital for breakthroughs in any field. The arts, in particular, are known to foster creativity as they require imagination, investigation, and the ability to think in new ways. Creativity leads to innovation when combined with knowledge, skills, and resources. For instance, creative thinking allows scientists to design new experiments, make new connections between existing research, and develop new hypotheses Apiola and others, 2012).

Whole-brain thinking refers to the ability to use both the left and right sides of the brain in a balanced and integrated way. The left side of the brain is responsible for logical and analytical thinking, while the right is responsible for creative and intuitive thinking (Herrmann, 1999).

Whole-brain thought is essential for innovation because it allows individuals to combine their logical and analytical abilities with creative and intuitive ones.

When we use both sides of the brain, we can think more critically, solve problems more effectively, and make better decisions. Whole-brain thinking allows individuals to view issues from multiple perspectives, which can lead to more comprehensive and innovative solutions. It also integrates different types of information, such as scientific data and artistic expression, which can lead to new insights and breakthroughs.

For example, the arts can help students understand scientific concepts more intuitively and relatable. By using both the left and right sides of the brain, students can better understand and retain scientific concepts, leading to more successful problem-solving and decision-making in the future. Integrating artistic and scientific thinking can also lead to new interdisciplinary approaches, design, architecture, and medical innovations.

Many studies have shown that an arts education can improve academic performance in math, reading, and science subjects. For example, a National Endowment for the Arts (NEA) study found that students who participate in music and theater programs have higher math and reading scores than those who do not. As mentioned earlier, the arts encourage creativity and innovation, which are essential for success in any field. The ability to think outside the box and develop new ideas is highly valued in today's economy, and an arts education can help students develop these skills.

From a workforce development perspective, many of the most in-demand and highest-paying jobs in today's STEM/STEAM-driven economy require creativity, problem-solving, and

collaboration, developed through arts-integrated education. As such, the Arts help students develop essential emotional and social skills such as empathy, emotional intelligence, and self-awareness. Studies have shown that art education can improve students' emotional well-being and help them become more empathetic and compassionate. The Arts also help students appreciate and understand different cultures and societies (Lawrence & Phillips, 2002). Through art, students can learn about other cultures' customs, traditions, and history and better understand the world around them. These are essential aspects of learning and are related to STEM subjects and overall personal and social development.

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Additional Resources

NPR: Can Physicists Be Funny? from NPR All Things Considered, Science out of the Box: aired September 6, 20084:00 PM ET: https://www.npr.org/templates/story/story.php?storyId=94357426

Improv Encyclopedia: http://improvencyclopedia.org/index.html

Gwinn, P. *Group Improvisation: the manual of ensemble improv games*.

Halpern, C.; Close, D.; and Johnson, K. *Truth in Comedy*.

Johnstone, K. *Impro for Storytellers.*

Napier, M. *Improvise: Scene from the inside out.*

Spolin, V. *Theater Games for the Classroom: A teacher's handbook*.

McKnight, K. and Scruggs, M. *The Second City Guide to Improv in the Classroom.*

Tauber, R. and Mester, C.S. *Acting Lessons for Teachers: Using Performance Skills in the Classroom.*

Timpson, W. and Burgoyne, S. *Teaching and Performing: Ideas for Energizing Your Classes.*