The Role of Emotion in Korean STEAM Education

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Abstract

Korea has prioritized STEAM (Science, Technology, Engineering and Mathematics infused with the Arts) education, and not STEM education, due to its inherently artistic and aesthetic culture. Meanwhile in the West, there has been a shift towards defining and measuring Social Emotional Learning (SEL) outcomes in STEAM education. SEL is a better predictor of student performance than even IQ. I found n = 28 STEAM Education studies with the key word of "emotion" in KoreaScience, the national science database. Information was gathered in terms of a) positive and negative findings of STEAM education studies involving emotion both quantitatively and qualitatively, and b) measurements of emotion in STEAM education research studies as both IVs (independent variables) and DVs (dependent variables). Korean emotionally engineered STEAM lessons have been successful in increasing scientific interest and attitudes, as well as emotional intelligence, compared to standard lessons. Korean evaluators, teachers, and students still noted the difficulty of conceptualizing, measuring, and tracking emotion in STEAM education research. Western researchers may consider adopting these techniques in their STEAM education, SEL, and related field research and evaluation efforts.

1. Introduction

Learning STEAM education is STEM Education (Science, Technology, Engineering, and Mathematics) infused with the Arts. Western science has largely prioritized STEM education, with STEAM education beginning later than STEM but increasingly making inroads [1]. In contrast, in 2011 Korea made STEAM, and not STEM, education a national priority, as there is a long history of arts and aesthetics in Korean culture [2], [3].

The inclusion of the Arts into STEM to produce STEAM education introduces an emotional component into the research equation and opens the door to the measurement of Social-Emotional Learning (SEL) outcomes. Creative design and emotional experience are key pillars of the Korean STEAM education framework, based on guidance from STEAM education's founder, Georgette Yakman (see Figure 1). Therefore, it is not surprising that Korean STEAM education curriculum designers and researchers have made emotion a priority.

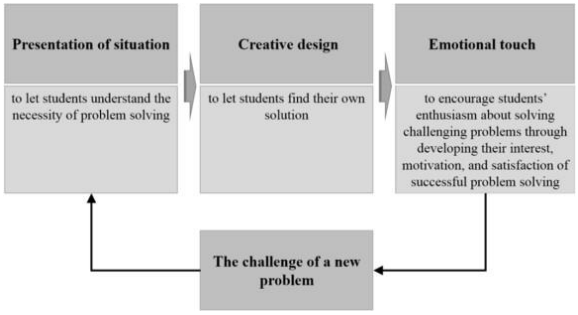

Figure 1. Pillars of Korean STEAM education [4]

The importance of SEL principles to STEM and STEAM education are noted in both the East [5] and the West [6]. SEL is a better predictor of school performance than even IQ [3]. According to the US Committee for Children, SEL involves:

a. maintaining cooperative relationships,

b. making responsible decisions,

c. managing strong emotions and exerting self-control,

d. communicating clearly,

e. solving problems effectively,

f. recognizing emotions in oneself and others, and

g. possessing empathy [7].

However, recent Western systematic reviews and syntheses of literature [8], [9] have noted the lack of assessment of SEL measures in Western STEM and STEAM education, as part of a lack of assessment of these measures in Western education generally.

2. Literature Review

Korea has become one of the most technologically advanced countries in the world [10]. Korean STEAM education has a strong evaluative arm, with researchers, teachers, and even students contributing to STEAM education research. Korean STEM journal articles are found in the online database, KoreaScience. KoreaScience translates titles and abstracts into English [11], indicating an olive branch

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extended to Western researchers. This database doesn't include the Master's Theses and Doctoral Dissertations written on STEAM education, which can be written in either Korean English. Some prestigious Korean universities actually prefer such papers to be written in English, to encourage cooperation between cultures and increase their own international competitiveness [12].

Koreans use various approaches to implement emotion into their STEAM education. They may use animals to provoke emotion in children and foster a sense of empathy. In one study [13], students imagine a tea part they would throw for the world. The lesson involved first showing students an "emotion doll" and asking them to think of words that express their hearts. Given the authentic situation of designing an invitation to this tea party, they then created an invitation using creative design principles. Emotional experiences in students were provoked by designing an imaginary program or play put on by the animals. A time of reflection for students then occurred. They observed seeds growing into plants, while thinking about how we all live on earth together.

Emotionally engineered lessons may also incorporate advanced technology. Examples include making astronomical displays using 3-D printers [14] and programming robots to do simple tasks [15].

Historically, Western educational and social science researchers have shied away from operationally defining, measuring, and seeking to systematically improve emotional metrics, largely leaving them to the clinical realm. However, in the last 10 years, Western researchers have started to see the value of seeking to reduce negative emotions, like depression and anxiety, which students may experience while learning complex subjects [1], [8]. There has also been a renewed research interest in studying positive emotions students may experience in the classroom by learning in collaborative teacher and student environments [11].

Western researchers have begun to compile what is known and what is not about STEM/STEAM education and SEL. According to Gabitova and Garner [16], "very little is known about whether learning in STEM is enhanced by the infusion of SEL content or whether SEL is a consequence of well-designed STEM education" (p. 1). And in a rare meta-data synthesis of STEAM education research, Rikoon et al. [13] noted that "as a proportion of the number of times SEL spaces were raised [in STEAM research], they were assessed relatively infrequently" (p. 13).

3. Methods

Reading titles and abstracts written in English of studies found in Korea's national science database, KoreaScience, using the search term "STEAM education" and searching for the keyword "emotion" in abstracts, I found n = 28 STEAM education studies on emotion from 2012 to 2024. The researcher, then translated the entire articles from Korean to English using Google Translate (this may be seen as a study limitation). Information was gathered in terms of a) positive and negative research findings of STEAM studies involving emotion quantitatively and qualitatively, and b) emotion in STEAM studies measured as either IVs (independent variables) or DVs (dependent variables).

4. Results

Theories on emotion were largely absent in Korean STEAM education studies. Researchers themselves served as curriculum designers, or expert STEAM teachers they recruited, who personally "emotionally engineered" STEAM education lessons. Emotions incorporated into these lessons furthermore reflected an Eastern bent. Using a field trip, one STEAM program employed topophilia (a love or nostalgia between a person and environment, from Chinese geographer Yi-Fu Tuan [17] to prompt creative insights.

Benefits of emotionally engineered lessons included increased or high levels of satisfaction, interest, and enjoyment of science and STEAM [18], [19]. In contrast, negative findings of emotionally enhanced STEAM education lessons included:

a. an increased risk of conflicts in team activities [18],

b. students with emotional issues having a hard time on a STEAM field trip that emphasized emotional experiences and quiet time [20], and

c. a student on the same STEAM field trip feeling that "there was not enough time to think deeply" when the goal was to facilitate creative thinking (p. 51) [20].

Students were asked in-depth questions on their emotional experiences. These included questions regarding how they felt at the beginning and end of lessons, if they expressed their emotions during the activities to teachers and students, and if they immersed themselves easily into the lessons. Koreans see this emotional immersion as facilitating new thoughts and ideas [18].

A qualitative study of expert STEAM teachers reported similar concerns with rigorously studying emotion. According to one teacher, "If emotional experience is an attitude that arises during the learning process, when will immersion occur? How can we understand emotional experiences that occur other than at the learning stage?" Another teacher stated, "If one of the elements of emotional experience is the challenge of a new task, it can only be confirmed with consecutive assignments. Since this is a one-time class, confirmation is not possible [13] (pp. 580-581).

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In terms of the second research aim, n = 2 studies manipulated emotion as an independent variable, or IV ("emotionally engineered" STEAM lesson vs. traditional STEAM or science lesson).

The first study was targeted to gifted 5th-grade students. They studied the "nature of light." Program students (n = 20) who received the "emotionally engineered" lessons designed PET (polyethylene terephthalate) bottles, made of a strong and lightweight plastic used mainly for packaging foods and beverages. Students practiced passing through them visible forms of light, along with some UV light, but not damaging light with UVB wavelengths [21]. The control students (n = 20) received a STEAM or science lesson from a textbook for gifted students.

The second study involved 4th-grade program students (n = 43) learning about the states of water, which include gas (vapor), liquid (water), and solid (ice). Program students experimented with new ways of recycling rainwater off of buildings so that it could be reused as drinkable water [13]. This is a practice that the East has been engaging in for centuries, which the West has only recently begun using to combat climate change. The control students (n = 40) received a more traditional science lecture. Despite the small sample sizes, students in both studies demonstrated increases in relevant outcomes from pre to post. These included creative thinking and emotional intelligence for gifted students [4], as well as emotional intelligence and science-related interests and attitudes for general students [6].

A different emotionally engineered STEAM program involved reading poetry to students for six sessions over the course of four weeks. Students demonstrated improvements in logical thinking in the areas of conservation (understanding the properties of an object stay the same even when its appearance changes) and combined logic (rules governing logic that computers use to make decisions) [22]. The "tea party to the world" STEAM lesson [14] targeted SEL improvement by having economically disadvantaged 3rd-4th grade program-only students (n = 32). While the study found improvements in student relationship skills, none of the many SEL outcomes assessed demonstrated improvement. These included self-awareness, self-management, social awareness, and responsible decision-making [22].

5. Discussion

Reported benefits of STEAM education found in Korea are similar to what has been found in the West. Korean STEAM education research has also found new drawbacks to incorporating emotion into STEAM lessons not found in the West, due to their unique and rigorous approach. Western researchers may already be adding "emotional touches" informally to their STEAM education lessons but not operationally defining them as "emotionally engineered." Additionally, the lack of improvement of SEL outcomes in this study corresponded to a lack of quality of SEL program elements found by Western researchers [9]. Korean STEAM education researchers are also measuring cognitive outcomes as DVs [14], a step towards learning about the uncertain relationship between STEAM education and SEL content and outcomes, suggested by Garner and Gabitova [16]. Study results indicate a causal pathway between learning in STEM/STEAM and the infusion of SEL content; this isn't to say there isn't a reciprocal causal mechanism as well.

Students' emotional immersion into lessons was sought after in Korean STEAM education. Emotion was also seen as pivotal to developing empathy for others and also plays a role in Design-Based Learning (DBL) in the West [2]. Additional research is found in the closely related field of Emotional Engineering Education (EEE). Lönngren et al. [23] have noted that EEE is a rapidly expanding, yet internationally dispersed field, in which researchers are unaware of one another's studies. Similar to STEAM education, EEE research employs a limited range of theoretical conceptualizations of emotion.

Zhang et al. [24] note four categories of emotion they found assessed in DBL education research for children, which are similar to concepts found in STEAM education research. These include:

a. achievement-based motivations in terms of design success and failure,

b. epistemic emotions triggered by cognitive problems while tackling new tasks,

c. emotions related to the topics of lessons, and

d. emotions related to social interactions within the classroom and in student group learning.

All four categories were covered in Korean STEAM education research involving emotion [12], [18], [4], [13], [5], [20], [21], [24], demonstrating a level of comprehensiveness.

Despite some congruence with these emotional categories found by Zhang et al. [25], this study was also in line with Lönngren et al. [23], in that there was a lack of theories on emotion in Korean STEAM education. A recent study by Lönngren et al. [26] alludes to five similar categories of emotion to Zhang et al. [25]:

a. Motor Expression,

b. Neurophysiology,

c. Subjective Feeling,

d. Motivation, and

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e. Cognition.

All the above researchers recommend incorporating psychological, sociological, and critical theories on emotion into STEAM education/SEL studies. Theories on emotion relevant to EEE and DBL may fit under the same umbrella as those used to study STEAM education and SEL.

6. Conclusions

The Western STEAM education research is starting to acknowledge the importance of SEL, findings from this review still point to the dire need for more research. Western STEAM education researchers may benefit from studying emotion more rigorously, similar to Korea. This may involve a) asking more in-depth qualitative questions on emotion to administrators, teachers, and even students, b) conducting experimental research with IVs that compare emotionally engineered lessons to traditional lessons, and c) experimentally measuring SEL, as well as cognitive outcomes, as DVs.

This study has provided culture-specific information on emotion and technological education, answering a recent call for more research in this area [26]. More concerted international research efforts to eliminate language and cultural barriers, ensuring successful cross-cultural collaboration, is needed to continue to fill in gaps in the literature bases of STEAM education, SEL, and related fields.

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