



STEAM approach for improving 21st century skills of multicultural students attending inclusive classroom

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Abstract

Since educational institutions were concerned with the development of special education needs, various techniques of instructional practices have been discovered and an inclusive concept has become more realistic. This experimental research aimed to study the level of eight 21st century skills which include English literacy, numeracy, scientific literacy, problem-solving, creativity, communication, collaboration, and social and cultural awareness of the students in inclusive classroom, to examine the level of eight 21st century skills of the students in inclusive classroom after intervened by STEAM approach. Sixteen grade 6 students attended the inclusive classroom for two semesters, plus three children with autism. The theme for the first semester was “mix-match-make to be the pastry baker,” and the other for the second semester was “design thinking producing gadgets.” The findings revealed that after completing two-semester projects, all eight 21st century skills of sixteen participants had been promoted as there were significantly different scores between pre-test and post-test ($p \leq .01$). In the case of the three autistic participants, the development of eight skills was reported by parents and the special education teachers, and all skills had reported improvement. The research findings would directly be beneficial to the special education teachers who are working on inclusive education as the process of teaching can be adopted in various classrooms and would give rise to the government sectors or relevant organizations to support or conduct research supporting sustainable development goals.

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Introduction

According to sustainable development goal 4, Education for All seems to be pivotal in enabling the education in each country to be capable of raising citizens' quality of life and sustainable human and social

development. As no one must be left behind, those with disabilities or ones with difficulties to access information or education would be recognized as the priorities to obtain the opportunity in education. In the case of Thailand, there are not enough spaces for these priorities to access proper education; therefore, this might be both the starting point and turning point of education in the country. An inclusive classroom is one of the effective solutions aiming to promote equality and quality in society.

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The inclusive classroom allows both general education teachers and special education teachers to work together to respond to the actual needs of students. Additionally, blending special needs students into the classroom with other students could help enhance most 21st century skills of the students, namely, collaboration, communication, and social and cultural awareness.

However, there are various skills as subcategories of 21st century skills. Inclusive education benefits intensively special needs students as well as other students in the classroom. In the case of students with special needs, they would develop foundational literacies while participating in the class with other students; they have a chance to observe classmates' learning styles and might absorb their ideas. In addition, those with special needs would enhance their competency in communication and collaboration through the participation in the classroom. To promote the collaboration between special needs students and other students, teachers must combine the PBL projects or any other approach which help encourage students to develop their foundational literacies and character qualities along with collaboration and communication that are parts of competencies in 21st century skills.

When mentioning the educational approach, the one that comes to mind is the STEM approach, which is the combination of science, technology, engineering, and mathematics. However, in the Thai context, particularly in inclusive classrooms, art is a major key to help convey the message or be one of the potential activities to promote students' creativity, initiative, grit, and adaptability. Hence, the STEAM approach might fit the Thai context more compared to STEM. The STEAM approach includes science, technology, engineering, the arts, and mathematics, which help guide student inquiry, dialogue, and critical thinking. The expected final consequences are the development of 21st century skills of students.

Hence, to enhance autistic students' 21st century skills, STEAM could be the best approach to provide these students with the opportunity to work with other students in the class and take part in creating some innovation in order to develop their literacy, numeracy, scientific literacy, problem-solving, creativity, communication, and collaboration. A class with projects would trigger the abilities of autistic students and establish the space for them to express their ideas and collaborate within the group, which would help them develop their communicative skill. In addition, learning via STEAM projects can construct the problem-solving skill for autistic children since they have to use the process of learning step-by-step because the project employs the scientific approach, which requires the problem-solving skill.

This research study views inclusive education as a source of multicultural students as there are different types of students studying together in the same class. The quasi-experimental research design is employed to intervene in the STEAM approach in the inclusive classroom aiming to promote the students' 21st century skills. Because of less popularity than the STEM approach, the researcher would design and utilize the STEAM approach to improve some 21st century skills; literacy, numeracy, scientific literacy, problem-solving, creativity, communication, collaboration, and social and cultural awareness.

It is inevitable to mention 21st century skills, as these days, there are numerous educational approaches for generation Z students. Some 21st century skills are discussed, for example; critical thinking, collaboration, creativity, motivation, and metacognition are studied as they are so significant for students. All of these skills are capable of promoting students' academic achievement. According to Maker (2004), creative thinking is a factor that helps enhance academic achievement of students. New ideas are the product of creative thinking. Educators, therefore, try to provide the students with the opportunity to explore any emerged ideas as the way they learn. According to Lubart and Guignard (2004), to move the fields forward, looking at prior ideas and integrating diverse concepts in new ways are the approach to innovations.

Metacognition and collaboration are other competencies in 21st century skills. During problem solving activities, metacognition, an ability to control one's thinking process via numerous strategies like monitoring, adapting, and organizing, might help to reimburse for deficits in intelligence or knowledge (Prins et al., 2006). In an inclusive classroom, students would benefit from having collaboration in class activities. It is a substantial factor powerfully affecting student learning. In case of special need students, they are given the prospect to have a collaboration with other students that strengthens their social skill as Ginsburg-Block, Rohrbeck and Fantuzzo (2006) revealed collaboration is able to produce the social competency of the students.

Inclusive Education in some countries has generated favorable outcomes. Students with disabilities participating in general education classrooms can improve the Individualized Education Plan (IEP), a plan that special education teachers construct for inclusive classrooms. According to Hunt and Farron-Davis (1992), the quality of IEP measured by aged-appropriateness, functionality, and generalization has increased. SDG4 states that equality

and the prospect of accessing the sources of knowledge of everyone should exist. Hence, it can be presumed the positive consequence in academic performance of the students with disabilities as The National Longitudinal Transition Study examined the outcomes of 11,000 students with disabilities and found fewer absences from school, fewer referrals for disruptive behavior, and better outcomes after high school in the aspects of career and independent life (Wagner et al., 2006).

To employ the education approach for inclusive classrooms, STEAM is one of the effective approaches that can lead students to develop their 21st century skills. This approach is well-recognized as a sophisticated driver of national economic growth; hence, to enhance young children's 21st century skills, STEAM curricula can endow them with exciting lessons to explore not only for disciplinary knowledge and skills, but also crucial higher-order abilities to survive in unprecedented development and disruption in this rapidly changing world. According to Boy (2013), STEAM is derived from STEM integrated into the Arts in order to promote creativity as well as rationalization, then return to STEAM. The concept varies the focus onto feasibility of longer-term socio-technical futures instead of short-term financial predictions that at the moment lead to uncontrolled economies. Therefore, the STEAM approach would help promote all students participating in inclusive classrooms.

This study comprises three elements; 21st century skills, inclusive education, and STEAM approach with the aim of encouraging SDG4. Given the immediate emergence of digital technologies and artificial intelligence, people must be well-prepared to adapt to the upcoming transformation of the environment. STEAM combined into an inclusive classroom can generate satisfying outcomes. This quasi-experimental research tends to promote subcategorized 21st century skills of primary students in inclusive classrooms by utilizing the STEAM approach.

Therefore, the objectives were to study the level of eight 21st century skills which include English literacy, numeracy, scientific literacy, problem-solving, creativity, communication, collaboration, and social and cultural awareness of the students in inclusive classroom and to examine the level of eight 21st century skills of the students in inclusive classroom after intervened by STEAM approach. Research Contributions are obvious as the research findings would directly be beneficial to the special education teachers who are working on inclusive education as the process of teaching can be adopted in various classrooms. Moreover, the results of the

effectiveness of inclusive education would provoke the government sectors or relevant organizations to support or conduct the research supporting SDG goals. Additionally, the lesson plans as interventions can be innovations for developing students' 21st century skills.

Methodology

This research is a quasi-experimental design emphasizing 3 pressing elements: 21st century skills, STEAM approach, and inclusive classroom. The interventions were the keys to develop students in the inclusive classroom in many aspects according to related research. The establishment of interventions rely on the STEAM approach as a type of project-based learning, but some more details were added in order to contribute in the Thai context. The sample groups were sixteen grade 6 students who attended the inclusive classroom for one semester, plus three children with autism. The purposive sampling design is employed to select the samples and the criteria are as follows; the students in the class must be in grade 6. The classroom must apply inclusive education plans. The parent involvement is one of the most important criteria (especially in the case of special needs students). The school director and the teachers must be willing to take part in this study. Additionally, the minor key informants for assessment are teachers, special education teachers, and parents of special need students. They are included in the in-depth interview as they are assessors and observers for this study.

Some 21st century skills were pretested by questionnaires. The researcher included pre-test and post-test in the forms of observation, interview and paper test, and questionnaire. The data collection methods included note-taking, observation, in-depth interview, and participatory observation. The researcher began implementing the interventions which included science, technology, engineering, arts, and mathematics for 6 weeks (for each semester), totaling 2 semesters. The second semester started two weeks after the end of the first semester.

Results

There are two main parts of the research findings to be reported as well as the established intervention. Also, each part is demonstrated by diverse data collecting methods, including in-depth interview, observation, and questionnaires (test paper).

Pre-test Findings

Before the intervention plan was created, the researcher collected the data on eight 21st century skills of all participants, which include English literacy, numeracy, scientific literacy, problem-solving, creativity, communication, collaboration, and social and cultural awareness. The pretest was divided into 2 groups; 16 students and 3 autistic children studying in grade 6 as presented in **Table 1** and **2**.

According to the scores presented in **Table 1**, eight skills were measured. The first three skills were measured by the test papers, with 100 points for total marks each. The average score of English literacy of sixteen students was 54.69, while for numeracy and scientific literacy they

were 60.69 and 59.82 respectively. The scores seem moderate.

The other average scores on problem-solving, creativity, communication, collaboration, and social and cultural awareness were 3.46, 3.26, 3.84, 3.80, and 3.78 respectively, measured by 5-point scales.

According to the findings presented in **Table 2**, it can be concluded that all three participants had been relatively competent in some skills such as English skills, numeracy, and communication; however, the other 21st century skills like problem-solving, collaboration, and social and cultural awareness were reported moderately low. Even though some skills seemed realistically gradual, they required the assistance from their parents and special teachers to move them step-by-step.

Table 1 Pre-test methods and mean scores of 21st century skills of sixteen grade 6 students

Skills	Measurement form	(n = 16)
English literacy	4-skill-test (100 pts)	54.69
Numeracy	Test paper (Geometry and numerical calculation) (100 pts)	60.69
Scientific literacy	Test paper (basic Physics, Chemistry and Biology) (100 pts)	59.82
Problem-solving	Questionnaire (consisting of 5-scale of measurement)	3.46
Creativity	Questionnaire (consisting of 5-scale of measurement)	3.26
Communication	Questionnaire (consisting of 5-scale of measurement)	3.84
Collaboration	Questionnaire (consisting of 5-scale of measurement)	3.80
Social and cultural awareness	Questionnaire (consisting of 5-scale of measurement)	3.78

Table 2 Pre-test methods and details of 21st century skills of three autistic students

Skills	Measurement form	(n = 3)
English literacy	4-skill-test and observation	They reported that they had understood most words studied; however, for reading, they all could read aloud, but were unable to understand the concept of the passage clearly without separating sentence-by-sentence. In listening and speaking, they all could answer some general questions like “What color is a tree?”, but it was quite difficult for them to answer How and Why? Interestingly, they can write sentences in English if the teachers spoke Thai and let them translate into English sentences, but just the use of “Present Simple Tense”. Overall, with the knowledge of vocabulary, these autistic participants could apply them into some communications with the help of teacher guidance.
Numeracy	Oral test and observation (Unit of weight and measures and numerical calculation)	Since the autistic participants were asked to add and subtract the ingredients, including sugar, flour, salt, and oil on the scale, they were keen on this task, but when teachers started problem solving like “How many kilograms are there if 2,000 grams is removed from 5.5 kilograms of sugar?”, it was quite challenging for them to convert measurement units. Also, they could complete multiplication and division without any assistance from the teachers; however, they were stuck when problem-solving tasks appeared.
Scientific literacy	Oral test (Questions and answers on a basic concept of science like water cycle and food chain)	All autistic participants were given a sheet showing water cycle and food chain, and they were asked to explain the phenomenon. The teachers reported that they could explain well when each step picture was pointed to, but not without pointing to each step. However, for the food chain, they just explained the animals shown in the chart. If the questions of the food chain were asked, around 40% could understand the concept and answer short questions.

Table 2 Continued

Skills	Measurement form	Research Findings (n = 3)
Problem-solving	In-depth interview with parents and special education teachers	Parents and special education teachers helped rate the problem-solving skills of those three participants. One of the autistic participants was outstanding in problem-solving as she could find something for rabbits to eat instead of carrots, which were not favorable for the rabbits at school. Holistically, the three autistic participants demonstrated a few problem-solving abilities, and teachers indicated that this must be due to a lack of apparent examples for students to learn.
Creativity	In-depth interview with parents and special education teachers	In the case of creativity, the teachers and parents reported in different dimensions. The teachers mentioned the sign of creativity of three participants based on the treatments they gave such as molding clay or painting, whereas their parents said their creativity could be observed during daily activities such as gardening and during Floortime therapy. However, most signs could be partially counted as a creativity, but it was always presented with the guiding activities.
Communication	In-depth interview with parents and special education teachers	Two autistic participants were reported high in communication since both of them had been participating in “speech therapy” for many years. In contrast, the other had some difficulties while having conversation with others since he always repeated the same questions and was talkative.
Collaboration	In-depth interview with parents and special education teachers	For this skill, all teachers and parents reported low grades due to the fact that the inclusive class contained special education teachers who took normal care and forced them to participate in each subject. This sounds manipulating and unnatural for developing the collaborative skill of the autistic participants.
Social and cultural awareness	In-depth interview with parents and special education teachers	In case of social and cultural awareness, the teachers and parents rated it moderately low as they presented the obscure sign of being aware of differences between them and others or showing empathy concerns.

Implementing Interventions

There were two semesters where the participants attended STEAM class. Each semester launched different themes of study. The theme for the first semester was “MIX-MATCH-MAKE to be the pastry baker” and the other for the second semester was “DESIGN THINKING producing gadgets.” The details of both mentioned themes are illustrated in [Table 3](#).

Two STEAM projects are exhibited in detail in [Table 3](#). For the project in the first semester called “MIX-MATCH-MAKE to be the pastry baker,” all participants had to create the cooking project as a business for the fair. The concept was based on pastry baking, which needed understanding the concepts of sciences, technology, mathematics, engineering, and art.

The project started with going shopping together, and the participants were given the lists of necessary ingredients under the consideration of the teachers and their parents as everyone could work on their own. It was quite evident that some participants who shared similar interests of opting for the menus were to be in the same teams, and chocolate as a major compound was on the top list of all followed by matcha green tea and sweet potato. There were 3 teams, each of which contained an autistic participant.

From the beginning, all students were informed about the contents to be learned, including Chemical Reaction in food processing, basic properties of Yeast and Baking

Soda, Chemical contained in chocolate, Geometry and Metric Systems, how to use computer to market the food products, arts of creating Scrap book and Cookbook, and Basic accounting.

In the case of the autistic participants, the researcher and the teachers assume their competency in that they can learn at a higher level of English, Mathematics, Science, and Technology contents. Therefore, a supportive environment had been created to assist their learning. The major task of the teachers and the researcher is to involve all participants incorporating real-world problems and questions. Two-way advantages of promoting empathy and collaboration could be perceived via the inclusive class, particularly with the STEAM approach. To clarify, the participants could enhance their understanding or empathy when collaborating with the autistic peers, while the autistic participants had opportunities to learn significant social cues through team projects. Hence, teaching students to understand the importance of collaboration was the initial challenge for the teachers.

For the project in the second semester called “DESIGN THINKING producing gadgets”, all participants had to create the project based on electronic principles as inventions for the exhibition. The concept was on circuit connections and ideas to solve current problems, which employed the process of design thinking to strengthen the concepts of sciences, technology, mathematics, engineering, and art.

Table 3 Detailed interventions for STEAM class of both semesters

Topic	Semester 1	Semester 2
Project Title	“MIX-MATCH-MAKE to be the pastry baker”	“DESIGN THINKING producing gadgets”
Objectives	<ul style="list-style-type: none"> - To strengthen literacy, numeracy, scientific literacy, problem-solving, creativity, communication, collaboration, and social and cultural awareness of grade 6 students. - To enhance the learning experiences and climates of all students by STEAM approach of which topic was favorable for all participants. - To promote participants' understanding in collaborating with special needs fellows. - To improve physical and academic skills of children with autism by STEAM approach set in an inclusive environment 	<ul style="list-style-type: none"> - To strengthen literacy, numeracy, scientific literacy, problem-solving, creativity, communication, collaboration, and social and cultural awareness of grade 6 students. - To educate the participants by implementing Design Thinking to improve their innovative thinking skill as well as entrepreneurship. - To encourage the participants to be inventors who can invent real gadget from their imagination based on the surveyed problems. - To strengthen the collaboration between students and autistic participants
Expected outcomes	<ul style="list-style-type: none"> - The participants can develop their literacy, numeracy, scientific literacy, problem-solving, creativity, communication, collaboration, and social and cultural awareness. - The participants' learning experience will be improved as they all are satisfied with lessons provided by teachers. - The participants become aware of collaborating with special needs fellows. - The participants' physical and academic skills, especially of the children with autism, will be promoted by STEAM approach set in an inclusive environment 	<ul style="list-style-type: none"> - The participants can develop their literacy, numeracy, scientific literacy, problem-solving, creativity, communication, collaboration, and social and cultural awareness. - The participants can enhance their ability of Design Thinking and Entrepreneurship. - The participants can create innovations aiming to solve the current problems systematically. - Both participants and autistic fellows can develop positive collaboration.
How to assess the students' 21st century skills	<ul style="list-style-type: none"> - Test paper on English 4-skill-test including 3 reading passages (20 pts), 30-item listening test (30 pts), writing essay (30 pts), and speaking and presentation (20 pts) - Test paper on Geometry and metric systems as well as a basic accounting, which contains 30 items, 100 pts (Multiple choice) - Test paper on Elements, Compounds & Mixtures, chemicals in foods and minerals, which contains 30 items (Multiple choice), and on a biological process of yeast and other microorganisms used in the food industry, which contains 20 items (Multiple choice), total score is 100. - Questionnaires (consisting of 5-scale of measurement) measuring problem-solving, creativity, communication, collaboration, and social and cultural awareness. 	<ul style="list-style-type: none"> - Test paper on English 4-skill-test including 3 reading passages (20 pts), 30-item listening test (30 pts), writing essay (30 pts), and speaking and presentation (20 pts) - Test paper on unit of measurement and geometry as well as basic statistics, which contains 30 items, 100 pts (Multiple choice) - Test paper on Electric Physics, which contains 30 items (Multiple choice), and on Force, Mass, and Motion, which contains 20 items (Multiple choice), total score is 100. - Questionnaires (consisting of 5-scale of measurement) measuring problem-solving, creativity, communication, collaboration, and social and cultural awareness.
How to assess the autistic students' 21 st century skills	<ul style="list-style-type: none"> - English 4-skill-test and observation, including writing sentence in project report (40 pts), Q&A on the project (30 pts), reading aloud (10 pts), and reading comprehension (20 pts) - Test paper on Geometry and metric systems as well as a basic accounting, which contains 30 items, 100 pts (Multiple choice): the autistic students were asked to calculate step-by-step with the help of the teachers - Oral test on ingredients in the recipe they chose and beneficial minerals, which contains 15 questions, and on biological properties of yeast and other benefits of microorganism used in food industry, which contains 10 questions, total score is 100 evaluated by the teachers. - In-depth interview with parents and special education teachers to measure problem-solving, creativity, communication, collaboration, and social and cultural awareness. 	<ul style="list-style-type: none"> - English 4-skill-test and observation, including writing sentence in project report (40 pts), Q&A on the project (30 pts), reading aloud (10 pts), and reading comprehension (20 pts) - Test paper on unit of measurement and geometry as well as basic statistics, which is a performance test, 100 pts: the autistic students were asked to perform calculation step-by-step with the help of the teachers - Oral test on Electric Physics, which contains 15 questions for which the autistic students were asked to complete the electric circuit as problem solving tasks, and were questioned on the basic concept of Force, Mass, and Motion, total score is 100. - In-depth interview with parents and special education teachers to measure problem-solving, creativity, communication, collaboration, and social and cultural awareness.

The project started with brainstorming the current problems (team members were scrambled with one autistic peer per group as in the first semester). They all were then allowed to go out to make an interview or conduct a survey with targeted people. In this case, teachers, school officers, students, and other personnel such as chefs, sellers, and janitors had been interviewed to check whether the brainstormed problems mattered or not. Then the process of the design thinking was continued.

From the beginning, all students were informed about the contents to be learned, including Design Thinking Process (Empathize, Define, Ideate, Prototype, Test), Electric Physics, How to use electrical tools and equipment, Electricity Formulas, Geometry, Metric Systems, Basic statistics for survey research, and Architectural and machine design.

In the case of the autistic participants, this project of the second semester aimed at promoting 21st century skills of the autistic participants, emphasizing material and equipment comprehension. Multimodal methods to educate them to practice the use of hot-melt adhesive (HMA) and soldering iron were necessary for these autistic participants due to safety reasons. One of the most significant points to be considered was the learning atmosphere, particularly in the innovative class. A flexible seating arrangement and proper lighting could help minimize sensory stimulus, which influenced the autistic participants who needed calm spaces.

Post-test Findings

After the second semester had finished, the researcher collected the data with the assistance of the teachers and the parents of the autistic participants. The findings of this study are divided into three sections, including the findings from the test paper and questionnaire (for 16 participants), non-participatory observation (only for the autistic participants), and in-depth interview (only for the autistic participants). After the data collecting process, data analysis indicated the upward trend of 21st century skills of all participants (16 students and 3 autistic students).

Section 1: Test papers and questionnaires

Test papers and questionnaires were used to examine sixteen participants due to their ability to comprehend questions or statements on the paper themselves. The competencies of English literacy, numeracy, and scientific literacy were measured by the test papers established by the collaboration between the teachers and the researcher that all contents were related to the pre-test used in prior assessment.

According to **Table 4**, the post-test average scores of sixteen participants are higher than the pre-test taken previously. The average score of English literacy is 69.81, numeracy is 76.81, and scientific literacy is 77.50.

However, the questionnaires to measure the other 21st century skills, included problem-solving, creativity, communication, collaboration, and social and cultural awareness. All sixteen participants were asked to complete the questionnaires that all items established along with the pre-test ones. These were self-assessment forms, the results which are reported in **Table 5**.

From the post-test score in **Table 5**, the average scores of problem-solving, creativity, communication, collaboration, and social and cultural awareness are 4.10, 3.89, 4.23, 4.00, and 4.28 respectively. Obviously, all scores are higher than the pre-test scores of the identical skills.

According to paired test, *t*-test was conducted to compare between pre-test and post-test scores on eight 21st century skills of sixteen participants. There are significantly different scores between pre-test and post-test of all mentioned participants ($p \leq .01$).

Section 2: Observations

For autistic participants, the teachers and their parents were asked to report the score collected from oral tests and other related observations. Three related skills; English literacy, numeracy, and scientific literacy, were scored by those key persons mentioned. The derailed findings derived from the observation are as demonstrated in **Table 6**.

As seen from **Table 6**, written work as a project report reflected the development of English writing skill of three autistic participants as well as two other skills studied in this research. From the observation, each autistic participant had improved knowledge and skills in English, numeracy, and sciences. These can be noticed by the scores rated by the teachers.

Table 4 Post-test scores on English literacy, numeracy, and scientific literacy

(n = 16)		
Skills	Standard Deviation	Mean Score
English literacy	13.70	69.81
Numeracy	17.12	76.81
Scientific literacy	12.15	77.50

Table 5 Post-test scores on problem-solving, creativity, communication, collaboration, and social and cultural awareness (n = 16)

Skills	Standard Deviation	Mean Score
Problem-solving	0.57	4.10
Creativity	0.42	3.89
Communication	0.30	4.23
Collaboration	0.27	4.00
Social and cultural awareness	0.35	4.28

Table 6 Post-test scores on English literacy, numeracy, and scientific literacy of three autistic participants

Literacy areas	Autistic participant no.1	Autistic participant no.2	Autistic participant no.3
English literacy	The written work in his final report seemed excellent. Most words taught by the teachers had been used correctly. During Q&A, he did quite well, especially when asked to explain his prototype. In case of reading, he could read aloud perfectly even the longer words like ingredients, preservative, and gourmet, but it was somehow hard for him to understand some questions that tested their analytical skill.	She had done an excellent job on writing and reading aloud with minimal mistakes. The answer was quite longer than the others as she always repeated the question. She understood spoken English better than before. However, it was still challenging for her to complete some reading comprehension tasks. Without the assistance from the teachers, she could not focus on the multiple choice provided; however, she did better in translation.	After two projects, he could write better. Even though he could not use a variety of the words written into the projects, the second project report seemed developed due to most words on the provided vocab lists appearing on his report. In a part of Q&A, he seemed more confident to answer questions about both his projects, particularly the second project, which suited his interest. However, he exhibited a little improvement on reading comprehension as he could not get the main idea and retell the story, but it was better when separated into sentence-by-sentence.
Numeracy	He got a total score of 75, where the skill on geometry and metric systems seemed superior to basic accounting and statistics.	She got a total score of 68, where the skill on metric systems and basic accounting seemed superior to geometry and basic statistics.	He got a total score of 61, where the skill on metric systems seemed superior to the other contents.
Scientific literacy	He got a total score of 83, where electric physics and the basic concept of Force, Mass, and Motion seemed superior to food science and biology.	She got a total score of 89. After STEAM lessons, it seemed that she could understand the concepts and logics of sciences more easily through the experiment and the projects.	He got a total score of 71 and his skill on electric physics seemed remarkable. However, it was quite challenging for him to comprehend the concept of biology.

Section 3: In-depth interview

In order to measure the remaining 21st century skills; problem-solving, creativity, communication, collaboration, and social and cultural awareness, in-depth interviews with parents and special education teachers were conducted. The scope of the semi-structured set of questions relied on related concepts and theories. The examples of the questions are presented in Table 7.

According to Table 7, in-depth interviews from the

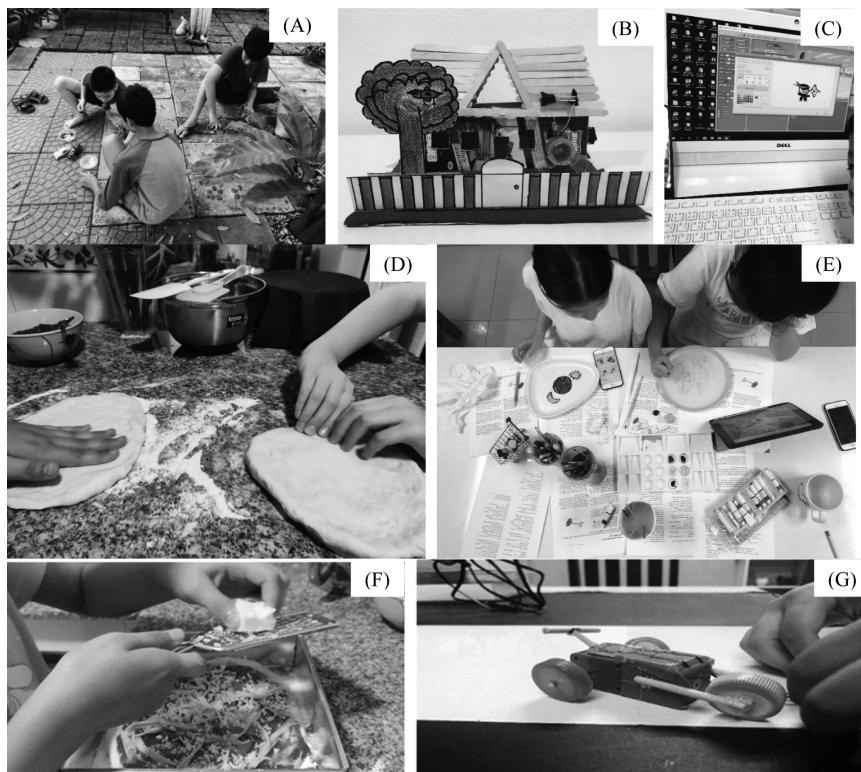
parents of autistic participants reflect the signs of development of those five skills. Overall, most of them feel more comfortable to participate in the class and join any offered activities. Moreover, with social inclusiveness, they can also develop further in other aspects such as Theory of Mind, Empathies, and cognition. These phenomena can prove the STEAM approach right in promoting a learning climate and 21st century skills of all students in an inclusive classroom.

Table 7 Examples of interview questions used to determine the development of problem-solving, creativity, communication, collaboration, and social and cultural awareness and the findings

Skills	Examples of the questions	Autistic participant no.1	Autistic participant no.2	Autistic participant no.3
Problem-solving	They are willing to face problems and make persistent efforts without being discouraged.	“After finishing project No.2, my son has made a stronger effort to walk through a problem by himself. For example, one evening, he found his cactus’s flower falling off, so he tried any way to fix it back on.”	“The projects helped her a lot to tackle the daily problem. She continually tried to finish her task of untying messy shoelaces.”	“He demonstrated his effort on baking a cake for my birthday although it is not his cup of tea. I saw him concentrate on following the instructions listed on the website I helped him find.”
Creativity	They often come up with new ideas to solve the problems.	“As seen from the way he tried to find creative ways to fix the flower back to the cactus stem, he experimented by first using a little leaf to hang the flower, but it didn’t work. The most stunning idea to solve the problem was when he took the straw to support the flower.”	“She is a pet lover. Every time she notices her cat behaving strangely; she tries various methods to help it. For example, she used a piece of cloth to cover it. I think she is a creative girl and she makes me happy.”	“My son showed a high creativity via the final project. He built a house for stray dogs. I think this is a sign of creativity, and he designed an elaborate building with the air-flowing system by combining renewable energy systems.”

Table 7 Continued

Skills	Examples of the questions	Autistic participant no.1	Autistic participant no.2	Autistic participant no.3
Communication	They have longer continual conversations with the teams, teachers, and parents.	“He is willing to have a longer conversation with his team. One day he said that he wanted to call his team to consult about the project.”	“Since the project continued, my daughter has become more confident to have a word with other students in the class. She feels more comfortable talking to other teachers as well.”	“He has developed his communicative skill as he knows more how to use gestures to help in communication. He uses his hands to show the sign of appreciation.”
Collaboration	They work in team collaboration, trust and respect one another.	“I would like to thank these projects that help my son to show respect to his peers. Also, he has become calmer when playing with his older sister.”	“My daughter isn’t a shy girl anymore. She learnt how to trust others. For example, she never cried anymore when I gave her doll to the housemaid to be washed.”	“I think this STEAM approach can help my son to start a conversation with other students. He often mentions some names of his team members.”
Social and cultural awareness	They improve an awareness of the value of being a part in the inclusive class projects.	“Every night before the STEAM class, my son always reminded me not to forget some stuff at school. This means he perceives the value of being in the class and becomes happier to get up early in the morning.”	“Even though normally she loves going to school, she now shows more energy and willingness to join the class, especially the one with group activities like ESL.”	“He cares more about the class rules as formerly, he was never concerned about them. For example, I tried to teach him to pack the right books into his backpack, but he didn’t care about this routine and was being complained to by the teachers.”

**Figure 1** Activities in the inclusive classroom: (A) Kinematics experiment, (B) Example prototype, (C) Coding class, (D) Chemical reaction in cooking class, (E) Painting experiment, (F) Ingredient measurement, and (G) Circuit test

Discussion

As discovered by the research, the STEAM approach, which is an integrated way, is one of the most effective ways to promote 21st century skills of students with the combination of meaningful subject areas, including math, science, technology, engineering, and art. Hands-on learning activities are the significant keys to enliven the learning process.

In the case of inclusive classrooms, some scholars began implementing STEAM into the class, and there are optimistic consequences of equipping students with 21st century skills. According to Tomar and Garg (2020), the STEAM model had been established to address the learning needs of inclusive classrooms. This study revealed the possibility that an emphasis on STEAM can make learning comprehensible and easily accessible for all.

To enhance youngsters' 21st century skills, particularly ones with disabilities, Zayyinah et al. (2022), reviewed the related research in literature and discovered that STEAM was built from various Project Based Learning, of which dimensions seem effective to develop 21st century skills. This study aimed at promoting eight 21st century skills, which involved English literacy, numeracy, scientific literacy, problem-solving, creativity, communication, collaboration, and social and cultural awareness; therefore, the researcher started STEAM in the inclusive class and conducted experimental research. It found that all eight mentioned skills can be enhanced with the implementation of 2-semester projects. Likewise, the study conducted by Ridwan et al. (2017) revealed that the STEAM approach helped develop the participants' higher order thinking skills, involving critical and creative thinking, problem-solving, collaboration and argumentation, information, literacy, and self-direction.

Conclusion and Recommendation

An inclusive classroom elevates the opportunities of special need children in promoting their social skills such as collaboration, adaption, and communication. By implementing the STEAM approach, an inclusive classroom propels participants to express creative and innovative ideas. Special need participants would be empowered to enhance their curiosity. If the proliferation of inclusive classroom concepts becomes the main concern, the purpose of Sustainable Development Goal 4 will be more optimistic.

Conflict of Interest

The author declares that there is no conflict of interest.

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