Using SketchUp for 3D Modeling in an Open Learning Environment

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Introduction

This design focuses on the importance of Open Learning environments to help students have interactive, organized, metacognitive and realistic learning experience. Collectively, student-centered, open learning environments provide contexts wherein the individual determines learning goals, learning means, or both the learning goals and means. The individual may also establish and pursue individual learning goals with few or no external boundaries as typical during spontaneous, self-initiated learning from the Web (Hannafin et al., 2014). This design will be produced to inculcate modern technology named 3D modeling in an Open Learning environment where students will have the autonomy to recognize their problems and find solutions. According to Gregory et al (2016), three-dimensional (3D) immersive virtual worlds have been touted as being capable of facilitating highly interactive, engaging, multimodal learning experiences. Students will explore the world of 3D modeling for their Visual Arts class with the help of the widely known tool, SketchUp.

Learning Difficulties

The main difficulties students face are that they do not know how to understand the purpose of creating an object by simply drawing it on paper. They find it boring just to draw flat surfaces and they can't have a 2D or 3D vision of it. They don't know how the other side works. They find it difficult to think of an idea to expand on the drawing they make. According to Sung et al (2015), most elementary school students only have the ability to summarize the properties of a picture or image, but are unable to perform further abstract comparisons. In other words, when a representation is not sufficiently concrete, students are more likely to experience learning difficulties. They can't have a transformative experience by mere flat pencil sketches. For example, if they want to create a real tissue paper box containing tissues in it from a simple

rectangular shape they drew on paper, they can't create a real life box of tissues. All they will do is just draw a flat, one-sided surface of a box and then they may color it for a fancy visual. So learning gets stuck here without any real life experience and growth. This traditional approach takes a lot of time to draw each side of the paper separately in order to show how the other side looks. There is no improvement in the learning skills of students. The problem is that memory functions in a way that makes it difficult for students to retrieve and use such knowledge (Schank et al., 1999).

Sometimes when they have to draw more than one object, they find it extremely hard to draw the sketches in proper sizes and shapes. For example, if they have to draw a glass and a plate and they should be in a tray, they find it difficult to draw all three objects in proper sizes. Sometimes they will draw a big sized glass, a small plate and even a smaller tray. Sometimes they may draw big glass and a plate that cannot fit in the tray. They just keep on erasing and redrawing until they draw required shapes and sizes. For that purpose they look for compasses, protectors, scales, erasers and other tools from their geometry boxes for exact measurements.

Problem Context

Students don't feel any interest in drawing pencil sketches any more. They get bored because they can't experience any innovation in their learning. They just draw a shape, character or object but can't feel whatever they have created. There is no development of their spatial abilities. Technology-oriented environments help improve the spatial abilities of students. According to Hannafin et al (2008), student spatial ability would predict success in such an environment more reliably than it would in the tutorial program. Even drawing their favorite characters like dragons, vampires, fairies, hobbits or unicorns in a traditional setup does not create any enthusiasm, charm or interest for them. They don't feel any connection with the real

world through their drawings because they just transfer the knowledge on paper that their teacher transmitted to them. Students don't feel any association with their creations. Their motivation level remains low most of the time. They don't feel any interest because they are not intrinsically motivated to do something different. According to Ormrod (2011), motivation often includes emotional engagement in the task at hand and that intrinsically motivated individuals typically find pleasure in what they're doing.

Students need something that may help them feel the characters they draw, objects they create, ideas they generate and for that too they want to know the purpose of doing it. They need to have a platform where their creative abilities are polished and where they can have hands-on experience of learning something new. They must be engaged in different interactive learning experiences through peer study or group work. Open-ended Learning environments provide several opportunities to students for collaborative work. Students can get highly creative through autonomy, relatedness and independence that OLEs offer. According to Hannafin et al (1999), OLEs emphasize the mediating role of the individual in uniquely defining meaning, establishing learning needs, determining learning goals, and engaging in learning activities. Students come up with their own definitions of certain issues and frame those issues in a context of what they already know and what they can expect to learn in future. The incorporation of different means of technology in these learning environments will be a bonus for students to develop their spatial abilities and to have a dynamic platform of learning.

The modules designed for this environment offer students to engage in teamwork where they will learn to transform their ideas into real life objects. Students working in groups can be exposed to different perspectives, which may be useful for developing solutions (Xe & Land, 2004). They will have a 2D and 3D experience of drawing. Elementary school students have

marvelous creative abilities and they are always ready to learn something new and better. 3D modeling via SketchUp will be an interesting medium for them to learn, create, analyze and evaluate. These days, SketchUp is being used at home, in school, and at work by any one with a need to represent 3D information the way it's meant to be represented. Google SketchUp (as it's now called) is available as a free download in six languages, and is just as popular internationally as it is in North America (Chopra, 2007). Constant feedback and timely scaffolding are other important elements to support children's critical thinking skills. They will also have a self-regulating experience through various activities and assessments in the class. Students who already know about this technology and software may be an exception but different tutorials and instructions are added in the design to create ease for the beginners. Students will work in groups mostly but for few activities, they will perform individually.

Needs Analysis

Computer-based technologies hold great promise both for increasing access to knowledge and as a means of promoting learning (Bransford et al., 2000). Although computer-based technologies are available in almost all the institutions of America, many institutions are unable to utilize this technology fully. Students can't just keep on using computers for tutorials or to paint one-dimensional drawings through the inbuilt painting tools of computers. Most of the teachers themselves are not well acquainted with the wonders of technology so they are still stuck with old methods of using computers. According to Ertmer et al (2012), the most commonly cited reason for lack of technology implementation in the classroom is inadequate professional development and training.

This design is based on the criterion that OLEs have set. According to Hannafin et al (1999) in an OLE, the individual determines how to proceed based on his or her unique needs,

perceptions, and experiences, distinguishes known from unknown, identifies resources available to support learning efforts, and formalizes and tests personal beliefs.

This project is going to focus on the following needs. There is an emerging need of familiarizing teachers with new methods of coaching, guidance and scaffolding via modern uses of technology like VR and AR. Students should be encouraged to adopt newness in learning. Students are distracted by the boredom and lack of interest in traditional classroom activities. They don't have real life experiences, as their learning seems to be superficial. Their performance is not assessed properly. Therefore, it is important to help students learn through real life experiences in a productive open learning environment.

Learners' Analysis

These students range from 8 to 10 years old. This age group has unique needs and they are remarkable at learning new things. Their ways of thinking and engaging with the world are absolutely tremendous. Renowned psychologists and educators like Lev Vygotsky and Maria Montessori also believe in the unique learning abilities of elementary school learners. According to EL Education, these children love to learn through playing and are usually very social. They deserve and need a learning community that is safe, idealistic and fun loving. They show wonder even at small things. They enjoy learning new things and look for independence, mastery and control. Their bodies are their biggest source to understand the world. They like building stories to construct meaning. They make patterns in their surroundings. It's commonly observed that they express themselves in complex ways.

The students chosen for this project are ELs in primary school. They range from 3rd to 4th Grade students. These students come from different backgrounds. Over 70% of students are from bilingual families. Many of them have poor economic conditions. Some have less or no support

from parents to study and others have difficulty going to school because of various reasons. The good thing is that almost all of them enjoy creative learning and want to be at the school lab to experience several makerspace opportunities. Thus, instruction requires a focus on problem based and real world learning that meet the demands of the 21st Century. Various donors have granted a sum of $5,000.00 for the school. iPads have been given to PK-2nd students and Chrome books are available for 3rd and 4th Grade students. Main focus will be on their past performances in Geometry and Visual Arts. Their overall performance is also focused.

Context Analysis

During the activities performed in the class, more attention will be paid towards the students, who have low economic backgrounds, those who have some emotional problems, some who have learning difficulties, students who may be disturbing children in any context and the ones who might have some health issues.

Task Analysis

The tasks designed for this project are based on Oklahoma Academic Standards for Visual Arts at 3rd and 4th Grade levels. These standards are VA.CP.2:, VA.CP.3:, VA.P.1:, VA.P.2:, VA.P.3:, and VA.P.4. Keeping in view these standards, 4 major tasks have been designed.

Task 1: Identify and practice drawing basic geometric shapes like circles, squares, triangles, and rectangles. Learn about 2D and 3D shapes and associate those shapes with the real life objects. Learn the difference between 2D and 3D keeping the terms shapes, lines, faces, edges and vertices in view. Draw imaginary or real life images based on these 2D and 3D shapes. This will be an individual task.

Task 2: Identify 2D and 3D objects in the surroundings. Start modeling 2D and 3D shapes to have a practical experience. Identify the importance of converting 2D shapes into 3D objects.

Task 3: Create 3D objects that should be from different non-living 2D shapes. Engage in a collaborative task for this activity. Value each other's contribution**.** Identify the potential of Visual Arts in various professional fields. Set personal goals for the future.

Task 4: Recall the difference between 2D and 3D shapes. Analyze the important vocabulary and concepts related to Visual Arts, synthesize that information into different categories and evaluate the worth of knowledge and skills utilized in the class. Apply that knowledge in real world situations especially in professional life. Select a theme to draw a number of 2D or 3D objects related to that theme. It could be recycling, cleanliness, decoration, grocery shopping and birthday parties etc. Use all the required and available resources and tools for that work of Art.

Using SketchUp motivates students to utilize their learning of basic geometry and Art forms in various other subjects like Mathematics, Writing, and other forms of Fine Arts like Dancing, Drama/Theatre and music.

Learning Objectives: Keeping in view Oklahoma Academic Standards for Visual Arts, following objectives will be observed.

1. Students will learn to differentiate between 2D and 3D shapes. They will learn the vocabulary related to these differences. They will draw different objects that may be 2D or 3D by recalling the knowledge they gained. They will be introduced to SketchUp .
2. Students will be able to recognize the value of basic shapes and why it is important to draw 2D shapes and then to convert them into various 3D objects.
3. Students will be able to recognize different 2D and 3D objects in their surroundings. They will create their favorite objects starting from 2D to 3D. They may start from non-living 2D shapes to any 3D object of their own choice.
4. Students will be able to rely on their own abilities to create any object from real life. They will be able to create an object and associate a story with it. This may increase their writing skills as well. Learning different shapes may increase their interest in Geometry.

Learning Objectives/Outcomes	**Domain/Aspect** (e.g. Cognitive and metacognitive, Affect motivation, emotion, attitudes, Psychomotor	**Type** (e.g., Intellectual Skills (concepts, process, rules, principles, analysis, synthesis, evaluation, application, problem solving, etc.) **Cognitive strategies** **Attitudes**: receive, accept, respond, etc.; Motor Skills	**Assessment Method**	**Appendix Description**
Objective 1 Identify 2D and 3D shapes and also learn the vocabulary related to them. Introduction to SketchUp.	Cognitive	Problem Solving	Practice questions about the shapes	Appendix F

Subordinate skill 1a) Learners will be able to recall the knowledge that gained and will draw new shapes on paper.	Cognitive	Conceptual clarity	Drill Sheet	Appendix G
Subordinate skill 1b) Students learn to differentiate between 2D and 3D shapes	Cognitive	Learning basic concepts	Journal Prompt	_____
Objective 2) Students get motivation and confidence to model 3D objects from 2D shapes	Affective and cognitive both	Attitudes Problem solving	Peer Review	Appendix H
Subordinate skills 2a) Students realize their potential	Affective	Attitudes	Students Feedback Sheet	Appendix I
Objective 3) Students will be able to recognize the connection between 2D and 3D shapes and why it is important to understand this connection before modeling.	Cognitive	Analysis and synthesis	Discussions about problems faced	Appendix J
Subordinate 3a) Students will be able to retrieve their knowledge.	Cognitive	Knowledge, Concepts	Review about their experience of using SketchUp to convert shapes	Appendix K

Objective 4) Students will create any object from real life and will associate a story or experience to it.	Cognitive	Knowledge: Concepts		
Subordinate skill 4a) Students will be able to apply their knowledge in real life.	Cognitive	Knowledge, Analysis, Application	Review about the activity	Appendix L

Instructional Strategies

Objectives	**Type of learning outcomes** (e.g., concepts, rules and principles, problem solving	**Instructional Strategies – Supplanted** (e.g., Graphic as an advanced organizer, PPT presentation	**Instructional Strategies - Generative** (e.g., questions prompts; advanced organizer; explain)	**Rationale for strategy selection**	**Assessment approach / Item**
Objective 1 Identify 2D and 3D shapes and also learn the vocabulary related to them. Introduction to SketchUp	Analyzing	SketchUp tutorial to identify 2D and 3D shapes (see Appendix E). Tutorials about the difference between these shapes and the vocabulary attached to them (see Appendix E).	1.Individual task, 2.Explain the shapes with vocabulary. 3.Practice questions (attached separately) (Appendix F)	1. Merrill's Principles of Instruction 2. Demonstrate knowledge and Activate information by linking pre-existing knowledge and then be able to build on their current knowledge (scaffolding)	Appendix A Worksheet based on 2D and 3D shapes.

Subordinate skill 1a) Learners will be able to recall the knowledge that gained and will draw new shapes on paper.	Intellectual Skills (Concept)	Drill sheet (Attached separately) (Appendix G)	Helping students work on their sheets	Activating students to recall	Appendix B Worksheet to draw non-living 3D objects.
Subordinate skill 1b) Students learn to differentiate between 2D and 3D shapes	Intellectual Skills (Concepts)	Journal Prompt Review	Monitoring students	Merrill's Principles of Instruction Integrate: adding meaning and context between 2D and 3D shapes	Appendix C Short answer questions related to vocabulary
Objective 2) Students get motivation and confidence to model 3D objects from 2D shapes	Affective	Journal prompts in the beginning and the end of the unit Peer Review (Appendix H)	Group work Reflecting and monitoring students' feelings	Metacognitive Scaffolding Demonstrating by describing the activity Activating prior knowledge and engaging students in activities	Journal Prompts
Subordinate skills 2a) Students realize their potential	Affective	Displaying students' art on the separators available in the class. Students give feedback on each others work (Appendix I)	Monitoring progress and instructing students	Metacognitive Scaffolding: Help students regulate and evaluate themselves	Journal Prompts

Objective 3) Students will be able to recognize the connection between 2D and 3D shapes and will know why it is important to understand this connection before modeling 3D objects.	Intellectual Skills - Analyzing	SketchUp modeling process Discussion about problems faced (Review sheet attached separately) (Appendix J)	Group Work Helping students use the tools effectively. Procedural scaffolding	Merrill's Principles of Instruction Demonstrating by describing the activity Activate, Integrate: Activating prior knowledge and integrating meaning to the conversion of 2D to 3D	Journal Prompts
Subordinate 3a) Students will be able to retrieve their knowledge	Intellectual Skills Concept	Review about their experience of using SketchUp to convert shapes (Appendix K)	Journal Prompt Group work	Merrill's Principles of Instruction - Activate Looking at prior knowledge and being able to connect it with existing knowledge	Journal Prompts
Objective 4) Students will create any object from real life and will associate a story or experience to it.	Intellectual Skills Analyzing	Describing the themes selected and how the story should be created after modeling those themes.	Monitoring and procedural scaffolding	Merrill's Principles of Instruction Demonstrating the activity Activate, Engage – Activating prior knowledge and students will be engaged with the content to be able to apply their learning in real life	Worksheet Appendix D

Subordinate skill 4a) Students will be able to apply their knowledge in real life.	Concept	Recalling the knowledge gained. Review about the activity (Appendix L)	Monitoring, procedural scaffolding,	Merrill's Principles of Instruction Integrate: adding meaning and context between creation and real life application	Journal Prompt

Design of Learning Environments

This design is built on the basis of Hannafin's constructivist Open Learning Environments. OLEs tend to be especially important in promoting divergent thinking and in situations where multiple perspectives are valued, rather than a single "correct" perspective (Hannafin et al., 1999). Students are not stuck to one single approach. Through these learning environments, they get multiple choices and 'flexible understanding' (Hannafin et al., 1999) to perform an activity, search any relevant material, comprehend in their own way, analyze creatively, transfer in their own style and be active members of the knowledge construction process. Cognition and context are strongly connected to each other in OLEs.

OLEs are student-centered environments. OLEs foster critical thinking skills of students. Through this self-directed learning, students gain autonomy and their metacognitive skills are polished. OLEs are the best source to provide hands-on, concrete experience in order to solve authentic problems. The tools and resources students use in these classrooms are extremely helpful in the process of learning and construction of knowledge. The individual determines how to proceed based on his or her unique needs, perceptions, and experiences, distinguishes known from unknown, identifies resources available to support learning efforts, and formalizes and tests personal beliefs (Hannafin et al., 1999).

Open-ended Learning Environments

Open-ended learning environments (OELEs) have been touted to support the building and evolving processes associated with self-directed learning (Land & Hannafin, 1996). Some school systems are still focused on closed learning, cramming facts, and taking tests. OELEs have a unique way of developing student engagement and they help students get more creative, critical and independent. OELEs promote self-directed learning in learners. OELEs provide technological tools and resources for manipulating and exploring concepts (Land & Hannafin, 1996). Open-ended learning environments are comprehensive, integrated systems that promote cognitive engagement through learner-centered activities, concrete manipulation, and guided exploration (Hannafin, 1995). Open-ended learning involves learning processes that are mediated by the unique intentions and purposes of individuals (Land & Hannafin, 1996). Open-ended learning refers to processes wherein the intents and purposes of the individuals are uniquely established and pursued (Hannafin et al., 1994). OELEs are designed to support the individual's efforts to understand that which he or she determines to be important. They are not unitary in meaning, but are manifested in varied forms. Still, they share common assumptions which are represented by a set of dimensions: scope, content, integration, user activity, and pedagogical orientation (Hannafin, 1992). While the opportunities afforded by OELEs for enhancing learning are substantial, considerable challenges arise in their creation and implementation. OELEs come in many varieties (simplistic and focused; complicated and limitless) and can be manifested in several settings (face-to-face instruction, distance learning environments, computer assisted instruction, etc.) (Hill & Land, 1998). Technology is often used as a mediator of the process, providing learners with electronic means to search vast databases of resources and manipulate variables and concepts. Yet, fundamentally, OELEs support student-centered understanding -- the

learner is at the center of the environment both in terms of decisions for using the available resources and as the party with the primary responsibility for learning (Hill & Land, 1998).

Bransford's Four-Centered Learning Environment

According to Bransford et al (2000), the learning environment should be knowledge-centered, learner-centered, community-centered and assessment-centered. In this model, knowledge related to 2D and 3D shapes is provided. From beginning till the end, students get knowledge about the recognition of 2D and 3D shapes. They are provided with sufficient knowledge to differentiate between the two. They are also guided to relate their existing knowledge to the real world situations. Students go through a procedural knowledge from the beginning of using 3D modeling tool SketchUp till the end when final review is taken. Different tutorials, search engines, Oklahoma Academic Standards and instructors are the biggest sources to provide knowledge.

This design is learner-centered. Students are given various choices to find solutions for certain problems. Learners have the autonomy to perform all the activities with complete independence and free will. Learners use SketchUp as a tool to design 3D objects. Through SketchUp, students' spatial abilities are focused and their critical thinking skills are also monitored. Students are engaged in real world learning and they have developed a keen interest in 3D modeling for future references and professional uses.

While following the community-centered approach, this design has brought in different interactive activities through peer work and group tasks. Students develop good communication and collaborative skills by working together, assisting each other, valuing one another's opinions, generating and solving problems together and giving feedback. They develop a collaborative community and increase their social ties and critical thinking abilities.

Different assessments are conducted related to each module. These assessments include MCQs, Short Qs and As, Review and Drill sheets, Creating stories about the 3D objects and relating them to real life experiences. Different feedback sheets from teacher and students are also added. These assessments are not for credits. These are designed just to check the understanding and development of students' ability to use SketchUp in their 3D world.

Enabling Context

Including problem-solving methods, anchored instruction, and personal motivation of learners have helped design this instruction. OLE is preferred to generate solutions and develop various learning skills. Advanced form of technology in the form of 3D modeling is incorporated with the help of 3D software, SketchUp. Students think of various themes, associate their experiences with those themes, create different stories and derive a lesson from them. In this way their writing skills are also established. Thus OELE supports communication skills, collaborative skills, critical thinking skills, and anchored instruction. The way students are given autonomy to solve different problems increases their interest in different tasks and they relate their experiences with real life situations like choosing a profession in future. In this design, all activities involved in various modules indicate that all three types of contexts are kept in view which are externally imposed (problems of the learners), externally induced (problem context) and individually generated contexts (personally generated). Enabling contexts guide students in recognizing or generating problems to be addressed and framing learning needs (Hannafin et al., 1999).

Merrill's Principles of Instruction

This design follows Merrill's First Principles of Instruction and brings demonstration, activation, applying, engaging and integration into limelight. Teacher activates the prior knowledge of students about 2D and 3D shapes and provides verbal demonstrations. Students then apply their understanding about the differences between 2D and 3D shapes to solve different problems. Teachers engage them in various classroom activities by using SketchUp and finally students become able to integrate by finding meaning and context between existing knowledge and real world setting.

Scaffolding

Scaffolding is the process through which learning efforts are supported while engaging in OLE. Scaffolding can be differentiated by mechanisms and functions. Mechanisms emphasize the methods through which scaffolding is provided, while functions emphasize the purposes served (Hannafin et al., 1999). Cognitive, metacognitive and Procedural scaffoldings are used as resources to facilitate and develop the interest of students in 3D modeling different Art forms. Teachers help students solve different problems in using different tools especially when they change basic 3D objects to Art forms. Students are given autonomy to explore different tools and experiment with shapes, lines and objects. Although students have autonomy, still they need proper guidance and help at every step. Teachers provide feedback at every step and guide where students need to be guided. Mostly they solve their problems in a unique and independent way. Teachers will be there all the time to provide procedural scaffolding so that they may create, shape, reshape, move, erase, size, resize, duplicate, push or pull an object, rotate or finalize an object and seek help of the teacher whenever they get stuck during the procedure of making.

Teachers motivate students by making them feel as an important member of the class and by positive reinforcement or positive feedback.

Tools

Tools provide the overt means through which individuals engage and manipulate both resources and their own ideas. However, tool functions vary according to the OLE's enabling contexts as well as the intents of their users; the same technological tool can support different functions (Hannafin et al., 1999). Both students and teachers will use various processing tools like search engines, G Suite Applications, Communication tools like mails, group discussions, inquiry questions and manipulation tools like SketchUp.

Learning Outcomes

Students feel excited to be part of a 3D modeling collaborative team. They develop much interest to use SketchUp as an effective and free modeling tool that can motivate them to work collectively. Now they become able to create, understand, apply, synthesize, analyze, evaluate and reflect themselves in an Open-ended Learning environment. They also get inspired to use 3D models in real world scenarios to pave ways for STEAM professions.

Conclusion

Learning is a natural process and it happens at any moment. For better and formal learning skills, the role of learning spaces and instructional strategies is indispensable. This design puts an emphasis on learning by doing so that students may feel a responsibility to be an active member of the classroom. According to Schank et al, (1999), life requires us to do, more than it requires us to know. Students in this kind of learning space experience collaboration, team work, autonomy, appreciation, acknowledgement, innovation, application, problem solving,

creativity, evaluation, feedback, effective scaffolding, assessments, self-regulation, self-direction, self-reflection and finally learning.

Instructional Plan

Module 1 80 Min	Module 1 is of introductory nature. Students will be learning about basic 2D and 3D shapes, their differences and 3D modeling tool, SketchUp will be introduced to draw different 2D and 3D shapes and objects.

Task 1 45 Min	**<u>Instruction Time</u>** Teacher shows a Tutorial video 1 (Appendix E) about 2D and 3D shapes. She demonstrates and activates students' prior knowledge about these shapes. She distributes the drill sheets (Appendix G) among students containing different shapes and students have to identify them. Then she shows Tutorial video 2 (Appendix E) about the differences of 2D and 3D shapes. She explains the vocabulary this tutorial contains and distributes sheets (Appendix F) containing practice questions about the vocabulary. Teacher shows a Tutorial video 3 about SketchUp, how it works and how it can be accessed easily through free version. Screenshots of SketchUp free tutorials and link of Tutorial video 3 are attached (Appendix E)**.** At the end of the tasks, the teacher gives students assessment sheets (Appendix A, B, and C). These are not graded assessments. They are designed just to check the understanding of students. They will try to use it on their own and build basic shapes and objects. At the end of all the activities, students will start working on Assessment sheets (Appendix A, B, and C) **<u>Students' Participation</u>** Students watch the Tutorial video 1 and learn about 2D and 3D shapes. Their cognitive abilities are highlighted when they share their prior knowledge. Students work on the drill sheets individually (Appendix G). Students watch the Tutorial Video 2 and learn to differentiate between these shapes. They learn the vocabulary associated with different shapes. They draw different other objects from real life on paper that may represent 2D and 3D

	shapes. They are engaged in a problem solving activity now. Teacher monitors them and helps them understand the presented concepts. She helps them solve their problems during the procedure. They integrate meaning and context to differentiate between the two. Students work on Practice sheets (Appendix F) to recall the vocabulary about 2D and 3D. Students watch Tutorial Video 3 and learn how SketchUp works to create these shapes. They will try to build different 2D and 3D shapes on their own. (Screenshots of SketchUp free tutorial are also provided via Appendix E) After all the activities are finished, students will work on the assessment sheets (Appendix A, B, and C). For homework, students can watch other tutorial videos. The links to these videos are provided separately (Appendix N). They will practice building their favorite shapes at home.

Task 2 35 minutes	**<u>Instructional Strategies</u>** Teacher asks about the prior knowledge of students. She shows Tutorial video 4 (Appendix E) to students about why we convert 2D shapes into 3D objects. She then asks students to identify 2D and 3D shapes in the objects that are spread around them in the classroom. Then they will be asked to think of any non-living 2D objects, build them through SketchUp. Then convert these 2D shapes into 3D objects. It will be a group activity. Teachers will be helping students through metacognitive scaffolding and will analyze their performance. Teachers will ask students to give their feedback on the works of their peers (Appendix H). Those sheets will be displayed on the separators available in the class. She will also take students' review about how was their experience of using SketchUp (Appendix I) **<u>Students' Performance</u>** Students get interested in creating these shapes after watching Tutorial Video 4 (Appendix E). They feel motivated because they have recognized their potential and now they are quite active to perform this activity. They will solve the problems that come their way with the help of the teacher's scaffolding and feedback. They will be working in groups. They will identify the 2D and 3D shapes around them and will start the procedure of creating. Procedural scaffolding will be much visible here. Students will display their work on the separators and will give feedback to each other (Appendix H) and will complete the review sheet (Appendix I)

Module 2 50 Minutes	Module 2 lets students dive deep into recognizing different tools of SketchUp. Students learn to convert 2D shapes to 3D and create more objects from the understanding of these shapes. Students get connected with their peers and work in groups.
Task 3 50 minutes	**Instructional Strategies** Here the task gets bigger. Teacher tests prior knowledge of students about the conversion and why it is important. Teacher asks students to think of any non-living 2D shapes and convert them into 3D objects. Once they are done doing that, one of the students will come and present their work. They will have to talk about the difficulties they faced, the tools they use and why did they create that particular object? Here the teacher activates and engages them in a more creative task and analyzes their understanding. After that students will give their review about the problems they faced using SketchUp (Appendix J) and they will also give a review about their experience of converting 2D shapes to 3D objects (Appendix K). Various links for tutorial videos about the problems of SketchUp are available on Canvas. They are included for future references. **Students' Performance** Students perform the activity in groups. They take the help of their teacher where they get stuck and present when they are done. Teacher does not select the presenters. They just volunteer. They complete the review sheets also at the end

Module 3 90 Min	Here students go through different transformative experiences and associate their learning experience with real world situations, incidents and experiences. They reflect their understanding and spatial abilities through the creation of various art designs
Task 4 90 Min	**<u>Instructional Strategies</u>** Teacher asks about the prior knowledge of students. Then she asks them to think of a theme like recycling, grocery shopping, birthday party or decorating a place. Then students will create maximum objects related to these themes. After that they will have to create a story based on that theme. They can write the story in paragraphs or just make bullet points on a paper. Through procedural scaffolding, teachers will analyze students' performance. This will be a group task. Students will then present what they have created and their creations will be displayed on Canvas Creative board. They will be given worksheets related to this task (Appendix D). At the end, students will give their reviews about the activity (Appendix L) **<u>Students' Performance</u>** Students will listen to the instructions carefully. They will think of their favorite theme and will start creating their situations on SketchUp. They will share their views and work together. Once they are done, they will present by volunteering and this time the students should be different from the previous activity. After their activity, they will give their reviews about the activity (Appendix L). At the end, their creations will be displayed on the Canvas Creative Board.

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Appendices