Taking Making into Challenge Contexts:

A Toolkit Fostering Curiosity, Imagination and Active Learning

Acknowledgements 2018

Taking Making Into Classrooms in Challenging Contexts: A Toolkit Fostering Curiosity, Imagination and Active Learning
by Dr. Susan Crichton and Dr. Wachira Nicholas

We agree with Margaret Mead when she said,
Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has.

With a great deal of humility and thanks, we acknowledge friends and colleagues who contribute to the success of this publication.

- SESEA (Strengthening Education Systems in East Africa) a project co-funded by the Global Affairs Canada and Aga Khan University, East Africa (IED – AKU, EA)
- Institute of Education Development, Aga Khan University, East Africa (IED - AKU, EA)
- Innovative Learning Centre (ILC) – Faculty of Education | UBC Okanagan, especially Deb Carter, Research Project Coordinator
- Industry Training Authority in British Columbia (ITA BC)
- Skills Canada Alberta
- Ministry of Education - British Columbia
- Open School BC | www.openschool.bc.ca

Many thanks to the wonderful educators for contributing to our learning, especially

- Arua Core Primary Teachers' College and the Teachers and Tutors of Arua, Uganda
- Nachingwea Teachers College, especially the VP Louis Letta and Ally Athuhmani – Maker Space Room Coordinator
- Nicholas Wanjau Gakaguah, Aga Khan Primary School, Tanzania
- Primary Teachers in Nachingwea Region attending the November 2016 workshop
- The Department of Education | Mvomero District, Morogoro Region and the Teachers in the Turiani Region, especially Veronica Mdapo and Fatuma Jumbe
- Karine Veldhoen | NITEO Africa http://www.niteoafrica.org/
- Cindy Bourne, UBC Okanagan Faculty of Education GRIP Literacy projects in Tanzania and Ghana, especially to students Carley Bokor and Connor Pilling, and educators in Bolgatanga, Ghana

About the Toolkit Series

A goal of the Innovative Learning Centre (ILC, http://innovativelearningcentre.ca/) is to support educators and community members to take up and implement cross-curricular learning approaches that are grounded in hands-on, experiential active learning. The premise of the ILC community is based on the Japanese proverb -*None of us is as smart as all of us*!

Since 2008, ILC associates have worked collaboratively with colleagues at the Institute of Educational Development, Aga Khan University, East Africa (IED, AKU-EA) to bring innovation and pedagogical change to educators in East Africa.

Through these collaborations, the ILC has developed a series of toolkits and resources on a range of topics. Common to all the toolkits and ILC resources is a belief that individuals at any age and place can learn with good resources that support design thinking processes, tinkering, and purposeful play.

Taking Making into Challenging Contexts: A Toolkit Fostering Curiosity, Imagination and Active Learning version 2 is the sixth toolkit in this series.

Toolkits and Resources include:

1. ***Maker Day Toolkit*** version 2 (https://issuu.com/ubcedo/docs/makerdaytoolkitver2revisemay31e/1) provides the foundation for *Taking Making into Schools*, the research-informed immersive professional learning (RIPL) model. Since its launch in 2013 and revisions in 2015, the Maker Day Toolkit is available in various formats: print, ePub, PDF formats and editable MS Word files http://innovativelearningcentre.ca/thinkering/maker-days/maker-day-toolkit-in-word-docs/). A Maker Day supports educators and community organizers to facilitate new ways of engaging their constituent groups through sustained, effective and efficient professional learning

Why Taking Making into Schools Matters …

If you want to go fast, go alone.
If you want to go far, go together.
African Proverb

events. As of August 2016, various workshops and events have been offered to over 5,500 educators globally.

Thanks to funding from the Industry Training Authority of British Columbia (ITA BC), the *Maker Day Toolkit* has a downloadable PowerPoint with a series of videos that help to unpack the content in the toolkit (http://youth.itabc.ca/wp-content/uploads/2016/09/PlanningYourMakerDay_PPT2011.pptx). Additional videos are available that share experiences from various Maker Day events.

- https://www.youtube.com/watch?v=Z46INGogp7Q&feature=youtu.be
- https://www.youtube.com/watch?v=_nqjufBxUck&feature=youtu.be
- https://www.youtube.com/watch?v=5qfSG7yPJoY&feature=youtu.be

2. ***The unConference Toolkit*** (*https://issuu.com/ubcedo/docs/unconferencetoolkitaug27e*) was developed with in collaboration with the *Digital Opportunity Trust* (DOT - ***https://www.dotrust.org/***). As a Canadian-based NGO, DOT operates economic, education and leadership programs globally and develops the capacity of youth to become agents of change. Based on the central belief of youth empowerment, we believed the very structure of conferences and seminars needed to be reimagined. This reimagining enables the voice and active engagement of the most marginalized and novice participants, regardless of race, gender, religion, ability and / or culture. *The unConference Toolkit* shares conference structures with documentation proceedings, using graphic recording, and provides facilitation tips. This toolkit is available as an ePub or downloadable PDF file.

3. ***Toolkit for Challenging Contexts: Taking Making into Schools*** (*https://issuu.com/ubcedo/docs/toolkit4cc_english* and *https://issuu.com/ubcedo/docs/toolkit4cc_kiswahili*) was developed in collaboration with Dr. Lilian Vikiru, formerly with Institute of Educational Development, Aga Khan University, (IED - AKU), and teachers in rural Tanzania. The toolkit situates *Making* within the context of rural schools in *challenging contexts* - schools with few or no education resources, and limited or no access to the Internet, or stable electricity. The toolkit provides an introduction to *Making*, active student learning, and professional learning. It is available as an ePub, in both English and Kiswahili, the official language of much of East Africa. This toolkit was funded as part of a Canada-Africa Research Exchange Grant (CAREG). It is the foundation publication for ***Taking Making into Classrooms in Challenging Contexts: A Toolkit Fostering Curiosity, Imagination and Active Learning, version 2.***

4. ***The Coding and Microcontrollers in Design Thinking Toolkit*** was developed by Maria Royston and Bill Latta. Completed January 2016, it is available as an ePub (https://issuu.com/ubcedo/docs/diy_guidebook), and builds on the first *Appropriate Technologies Maker Day* co-facilitated by Women in Trades Training at Okanagan College (*http://www.okanagan.bc.ca/Programs/Areas_of_Study/trades/wtti.html*). This toolkit introduces users to the world of simple micro-processing and coding, without relying on expensive recipe driven kits or proprietary software and hardware.

Why Taking Making into Classrooms Matters …

You must be the change you wish to see in the world. Mahatma Gandhi

5. Building on the research-informed immersive professional learning model developed for the ***Maker Day Toolkit, Taking Making into Classrooms: A Toolkit for Fostering Curiosity and Imagination*** was developed in response to classroom teachers wanting to know more about introducing *Making* to their students. Two versions have been developed to assist teachers design and develop classroom learning opportunities.

   5.1 ***Taking Making into Classrooms: A Toolkit for Fostering Curiosity and Imagination*** (http://www.mytrainingbc.ca/maker/downloads/Taking_Making_into_Classrooms.pdf) which draws from the British Columbia Applied Design, Skills and Technologies (ADST) framework. This toolkit has a companion course for credit or non-credit self study.

   5.2 ***Taking Making into Classrooms: Fostering Curiosity and Imagination in Alberta Classrooms*** (http://skillsalberta.com/skills-exploration-days) which includes a Teacher's Guide to integrate *classroom learning activities* with *a learn-a-skill event* sponsored by *Skills Canada AB* and draws from the Career and Technology Foundations (CTF) program.

6. ***Taking Making into Classrooms in Challenging Contexts: A Toolkit Fostering Curiosity, Imagination and Active Learning*** version 2 is developed in collaboration with Dr. Wachira Nicholas, a professor at Institute of Educational Development, Aga Khan University, East Africa (IED – AKU, EA), and teachers from Dar es Salaam and Nachingwea region in Tanzania and Arua, Uganda. Like the 2016 version (https://issuu.com/ubcedo/docs/toolkitccresources_english_issuu), the addendum in 2017 https://issuu.com/ubcedo/docs/_atoolkit4ccv2addendum2017_englisht), and the third *Toolkit* (*https://issuu.com/ubcedo/docs/toolkit4cc_english* and *https://issuu.com/ubcedo/docs/toolkit4cc_kiswahili*), this resource situates *Making* within the context of schools in *challenging contexts* and positions *Making* as a way to engage teachers and students in active learning. It is available as an ePub (see https://issuu.com/ubcedo). It was funded by the ILC and SESEA (Strengthening Education Systems in East Africa), a project funded by the Canadian Department for International Development (DFID). Additional resources were developed with educators in Bolgatanga, Ghana, West Africa in conjunction with UBC Okanagan, Faculty of Education teacher candidates and Ms. Cindy Bourne.

A Note to Educators Using this Toolkit

The underlying philosophy of the entire Creative Commons, Open Access Toolkit Series is the Japanese proverb,

None of us is as smart as all of us!

Taking Making into Classrooms in Challenging Contexts: A Toolkit Fostering Curiosity, Imagination and Active Learning version 2 shares resources and supplemental materials designed and developed through ongoing workshops and various teaching and learning activities from the professional learning model, ***Toolkit for Challenging Contexts: Taking Making into Schools*** (https://issuu.com/ubcedo/docs/toolkit4cc_english), to encourage active learning through the creation of low cost or no cost resources. The toolkit is formatted to fit a ring binder so educators may add supplemental materials as they discover or share them.

As educators around the globe use the ILC toolkits, additional resources and support materials are added to the collective work to foster curiosity, imagination and active learning in their classrooms.

The Toolkit series will be maintained on the UBC Okanagan Education Issuu website (https://issuu.com/ubcedo). Additional information and resources from all the ILC publications reside on the ILC webpage (http://innovativelearningcentre.ca).

We are grateful to the following institutions and people who helped us along our way:

- Arua Core Primary Teachers' College and Teachers and Tutors in Arua, Uganda
- Nachingwea Regional Primary Teachers who attended the November 2016 workshop
- Nicholas Wanjau Gakaguah, Aga Khan Primary
- Nachingwea Teachers College, especially the VP Louis Letta and Ally Athuhmani
- Institute of Educational Development, Aga Khan University, East Africa (IED – AKU, EA)
- ILC, Faculty of Education, UBC

If we teach today's students as we taught yesterday's students, we rob our children of tomorrow.

~ John Dewey, 1916

Globally, countries struggle to make lasting, substantial reform. Initiatives such as the United Nations Millennium Goals (http://www.un.org/millenniumgoals/) have encouraged universal primary education and classroom changes that are student centred, evidence based, and encourage active and participatory learning. However, in some ways this has made teaching even more difficult as increasing numbers of students have taken advantage of free education and class sizes have increased into almost impossible numbers.

Welcome

Globally, educators are being invited to adopt more student-centred and active approaches to learning. Yet, all too often, educators struggle to change the most basic aspects of their classroom practice. This is especially true for those in *challenging contexts* where many educators teach in the ways they were taught – often using the *mind-numbing* practices of teacher-centred, rote instruction.

We use the term *challenging contexts* as a way to describe settings in which individuals have limited, unreliable or no access to modern day conveniences such as electricity, running water, health care, mobile computing, and related emerging technologies due to a variety of circumstances, conditions or environmental constraints. We recognize that challenges occur globally, varying in their scope, cause, duration, geography, and potential permanence.

Teachers in challenging contexts have a daunting task. The challenges they face include large class sizes, diverse learner abilities in a class, low literacy levels, lack of resources, serious underfunding, and lack of professional learning opportunities.

In East Africa teachers are required to teach an ever changing curriculum that increasingly embraces principles of active learning. Literacy and fluency in three subject areas (reading, writing and arithmetic) are seen as foundational to a strong academic start to a child's learning. However, the majority of teachers in challenging contexts have not been given adequate teacher training or ongoing professional learning opportunities to turn the Ministry of Education objectives into sustainable and relevant classroom practice.

Thanks to a SESEA project and prior funding from the International Development Research Centre's (IDRC) Canada Africa Research Exchange Grant (CAREG), we have worked with East African teachers and teacher college tutors to create this toolkit to encourage active learning through the creation of low cost or no cost resources.

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Toolkit Contents

Making is the core of what we call a pedagogy of promise – a pedagogy that encourages learning without penalizing students for mistakes.

Making allows students to celebrate the best gifts of humanity - the ability to think wisely, work creatively, and share generously (see Section 6 of this toolkit).

For teachers, Making is a meaningful way to introduce Science, Technology, Engineering, Mathematics and Design (STEMx) into existing curricular activities. For the case of East Africa, it provides a natural way to support students in large class groupings to work together and share both the process and product of their learning.

Section 1: Making and Its Importance in Active Learning in Challenging Contexts

1.1 An Introduction to Active Learning, Making and Challenging Contexts

When we *Take Making into Classrooms*, we invite our students to actively participate in learning by designing and building meaning, using real materials and tools. *Making* requires students to actively engage in the learning process and touch, play, use, reuse and explore good teacher-created resources and local materials. These tangible learning activities support and reinforce the core concepts and ideas that are being taught. *Making* helps teachers to integrate subjects and make meaningful connections between and cross discipline areas. It also helps teachers to develop quality resources that encourage active student engagement and participation in the process of learning. *Making* in classrooms is a natural way to learn. *Making* is both an instructional strategy and a content area to be learned.

East African teachers are required to use active learning strategies in their teaching. Like teachers in any other global context, East African teachers know that quality learning resources are essential to quality pedagogy. If teachers are to teach better and student are to engage actively in their learning, resources must be:

- readily available,
- designed to engage students in the learning,
- more than toys or props,
- contextually relevant,
- discipline specific,
- cultural sensitive, and
- adequate to support the number of students in the classroom.

Good Learning Resources

We suggest that teachers can create locally relevant, low cost or no cost resources that students can use. When students use culturally relevant, locally available items to learn with, there is tangible evidence that learning has occurred. Teachers can see where gaps in teaching and learning have occurred.

The difficulty in many classrooms in challenging contexts is that there are few, if any, commercial materials and resources for the students to engage with when they are trying to learn new concepts, ideas or content.

Good learning resources help in the following ways as they:

- enhance effective teaching making learning practical and tangible (physical),
- provoke students' thinking,
- encourage curiosity and questioning,
- encourage reflection,
- challenge previous learning and knowledge assumptions,
- accommodate knowledge building, and
- enable problem finding and problem solving.

Making integrates curricular concepts and ideas with imagination, creativity, problem finding and problem solving. *Making* helps to improve the quality of a child's educational experience. We know that context helps to determine what constitutes quality education. While issues such as equitable access to education for all and literacy and numeracy are global, some issues are contextually dependent, especially in challenging contexts. Challenging contexts in education exist everywhere.

They can be found in urban slums, remote rural villages, harsh geographically complicated regions, socially disadvantaged location, or economically disadvantaged areas. They can be found in urban and rural settings. They are found in the global north as well as the global south.

Challenges can be a combination of issues that make it difficult for teachers and learners to experience quality education. Some of these issues include high population, diverse learner abilities in a class, low literacy levels, lack of resources, serious underfunding, lack of professional learning opportunities, lack of enough qualified teachers, and many other related things. Such contexts render access to quality education more difficult, but not impossible. In fact, these issues could provide an opportunity to actualize transformative learning where educators are able to respond to the needs of individual students and the local society in the absence of external solutions that may be ill suited to the context. Our work with educators suggests that sometimes it is in the most challenging environments that educators have the most freedom and opportunity to be innovative and act creatively. They can seek to improve the quality of education given the difficult circumstances in which they operate, typically without the pressure or observation of external bodies or agencies.

1.2 Making and the United Nations Goals for Development and Sustainability

Education is both a goal and a catalyst for social and economic development. The importance of education is reflected in its inclusion in the Millennium Development Goals (MDGs). One of the MDGs is to achieve Universal Primary Education by ensuring “that by 2015, children everywhere, boys and girls alike will be able to complete a full course of primary education" (UN, 2015). Further, the MDGs confirm that education is instrumental to the achievement of the other Millennium Development Goals, recognizing that "educating children gives the next generation the tools to fight poverty and prevent disease, including malaria and AIDS" (UN, 2015).

Sadly, an assessment of the UN MDGs’ gains made so far indicates that the world has not achieved the 2015 goal of universal primary education.

Admittedly, there have been significant gains in access, but it has become evident that learning outcomes and relevance of the education are even more crucial in order for education to contribute to development. It is not enough for children to attend school; they must be given quality opportunities to learn when they are there.

The next stage of the UN Millennial Goal targets is the Sustainable Development Goals (SDGs). The SDGs recognize the need for each country to focus on the specific challenges it needs to overcome so as to attain contextually relevant and sustainable development (UN, 2014). We see the pedagogy of Making as a natural fit for schools as it links innovation, creativity, problem finding and problem solving in relation to the needs of particular contexts. If the children we are educating today are to tackle the problems of tomorrow, they need to know how to design and make substantive, sustainable change in an increasingly complex and globalized world. Children need access to active learning environments that challenge them to think creatively and critically and make meaning that is personally relevant and valued.

Making is a meaningful way for teachers to introduce good learning resources

1.3 Why Active Learning Matters

Teachers are mandated by their governments and other stakeholders to help students develop the skills necessary to be successful in an ever changing, globalized world. Teachers are told that these skills must be situated in accessible, flexible learning environments, but rarely are teachers given glimpses of what these learning environments might look like or offered practical suggestions of how they might create resources to development them in their own classroom contexts. Teachers are told that students must become active learners and that engaging in rote, teacher directed learning does not work; however, rarely are those teachers provided with ideas and opportunities to make the resources required to support active learning. Change requires a fundamental pedagogical shift: a shift to fostering the promise and potential of each child.

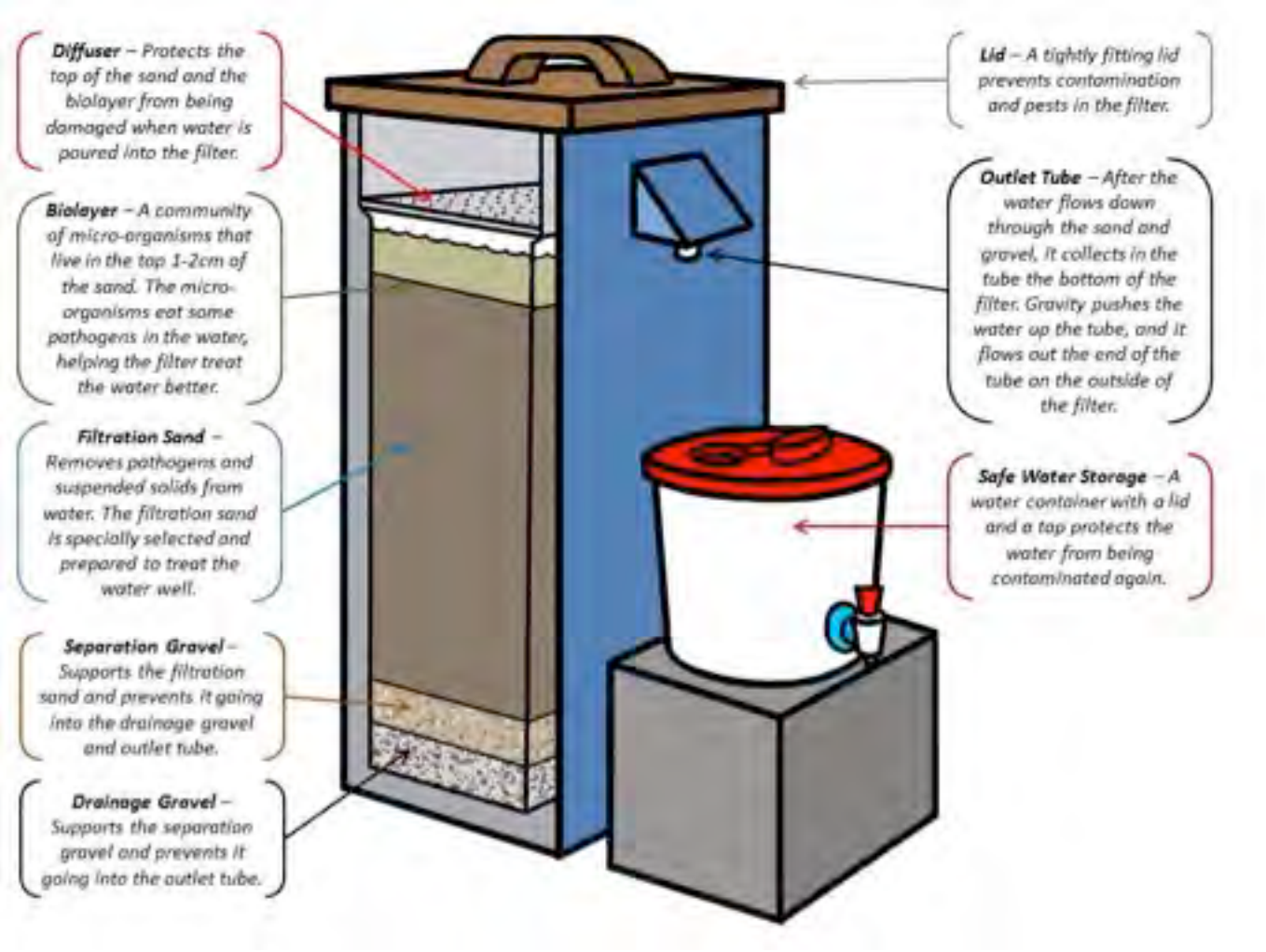
The Organisation for Economic Co-operation and Development (OECD) describes high quality learning environments as being:

- Learner-centered with significant, yet different, roles for teachers
- Structured and well-designed, requiring a high degree of professionalism to support the student inquiry and autonomous learning
- Profoundly personalized and acutely sensitive to individual and group differences and offering tailored, timely teacher feedback for learners
- Inclusive so as to be empathetic and sensitive to individual and group differences, and
- Social so learners can work collaboratively in group settings and connect to their larger community (OECD, 2011).

Currently, there is almost no limit to the amount of information we can get. We can download a version of the sum of human knowledge, in the form of Wikipedia, offline onto our phones, tablets or computers (http://www.labnol.org/software/download-wikipedia-offline/20012/).

Because we can access information so easily, we need our students to be able to think with the information, build personal knowledge, and make meaning for themselves. The ability to memorize facts is not as important as it once was. Basic literacy (how to read, write, do simple arithmetic, and recite information) is now not enough. Fluency (why, when, and how to use literacy creatively and

Teachers require time to discuss ideas and opportunities to make the resources required to support active learning



CAWST Biosand Filter: https://resources.cawst.org/construction_manual/a90b9f50/biosand-filter-construction-manual

make meaning) is essential. Fluent readers comprehend and subsequently create as confident writers. Fluency with mathematics offers the possibility for students to think flexibly and engage in mathematical problem solving.

We have the potential to learn, both formally and informally, at any time, place or in any format we need. Learning opportunities have probably never been more flexible. We can upgrade our skills using information we can get using a range of devices (i.e. mobile phones, tablets, computers). For example, we can improve our Calculus skills with help from Khan Academy (https://www.khanacademy.org/), or learn to build a sustainable and inexpensive water filter (www.cawst.org), or design a solar water heater (http://www.iwilltry.org/b/projects/build-a-simple-solar-water-heater/). Common to these examples is their innovation and response to an actual need. Information and facts can be gained from many sources, but good thinking needs to be developed. Therefore, teachers must develop ways in which students can actively engage with ideas, concepts and content and make their learning visible in tangible and thoughtful ways. We call this engagement fostering creative imagination – the ability to think beyond what currently exists.

We all enjoy tinkering and creating. It is in our DNA. It stems from our curiosity with the world and our basic desire to make things and then make those things better. Our earliest ancestors led the way in making when they crafted the first-hand tools in Africa and experimented with fire. They continued to make things and make those things better as they

adapted to new locations and migrated around the world. In recent years, people around the world have forgotten our love affair with making and moved away from traditional ways of doing things, often opting for cheaper, imported goods that appeared to be better and more modern.
While education has been touted as a key to positive transformation of the individual and the community, it can only attain this function if it is delivered in the right way. We now know that the mind numbing, repetitive practices of teacher-centered delivery does not necessarily result in learning. Teaching and listening do not automatically result in learning. In many of our schools in East Africa, more than 40% of our students do not continue their studies beyond primary education. We know that students lose interest because traditional pedagogical practices require them to be passive learners and because the teaching lacks applicability in their daily lives and in the careers they envisage. For example, in Tanzania in 2013, "… nation-wide research was conducted to assess Standard II pupils' competence in 3Rs. The intention of the assessment was to determine the pupils' ability in those basic skills. Results of the study revealed that there was an acutely low level of skills for pupils in the 3Rs." (MoESTV, 2016)

Transforming teaching and learning requires teachers to think of ways in which students can actively engage with their learning. A first step is to create a conducive learning environment that allows the learners to design and experience, critically reflect, and make meaning of their experience. Teaching and Making can lead to active learning that will be transformative.

Making in the school context presents a great opportunity for transformative learning because the learners can critically contemplate issues in their context. They engage in questioning and exploring, learning to articulate what they perceive are issues worth addressing. Through dialogue, they empathetically negotiate solutions and design and create solutions. Throughout this process, learners can take the lead in the activity while the teacher facilitates and offers guidance through informally assessing progress. Both the teacher and the learners learn from the process, articulating their understanding by co-designing and co-creating solutions. This learning can be well documented by observing the steps students take and evidenced in the solutions they create.

Making, the act of designing and building, has been successfully experienced in various contexts, including challenging contexts (i.e., aboriginal reserves in Canada, rural villages in East Africa). As stated previously, the key concerns associated with changing educational practices is to ensure learners are not just attending school but that they are actually learning. Teachers must become more motivated to spend more time in the classroom teaching and there should be evidence-based results. Making helps with this process as the teachers and learner are active and energized to learn together. When the students make things, their thinking is visible and evidence of learning is available. The act of Making helps to build the teachers' capacity to imagine and implement education in their own contexts as it draws from local resources and traditional ways of knowing and being.

Challenging Contexts in education exist everywhere.

1.4 Considering Multiple Forms of Literacy, Including Indigenous Knowledge

To be competitive in a globalized world, East African students must be fluent in multiple forms of literacy. Apart from traditional linguistic literacy – there is a need to embrace multi-literacies that represent different ways of knowing and expressing learning. New forms of literacy including media, digital, spatial, scientific, mathematical literacies which are crucial in accessing and utilizing the proliferation of knowledge that is at the disposal of the learner. Multi-literacies tie in well with Gardner's Multiple Intelligences. The recognition of multiple literacies in this way ensures that the development of multiple intelligences among learners are addressed. It also encourages collaboration and complementary working among learners which in turn fosters creativity and innovation as learners stretch their imagination and utilize their skills.

Active learning and Making encourages the construction of knowledge from prior knowledge

The contextual realities in which learners and teachers operate may either inform and support their creativity or constrain innovation and their creativity. The ability to leapfrog existing practice is a response to contextual realities. The term leapfrog is borrowed from the deployment of technology. One example of leapfrogging is in contexts where mobile telephony gained currency much faster than the installation of landline telephones allowing those users to quickly adapt newer technologies. Similarly, knowledge, information, skills and practices drawn from indigenous ways of knowing may inform innovation and creativity in similar ways resulting in leapfrogging of educational practices. Indigenous forms of knowledge include folklore; artifacts (i.e., tools, art, crafts); environmental resources (i.e., plants, animals); learning systems; taxonomies; laws; and forms of communication and organization. These indigenous ways of knowing are the sources of background contextual knowledge and skills that the learner brings to class. Indigenous knowledge also provides a base and source of linguistic, mathematical and scientific content for developing learners' competences in early years. This

knowledge forms the base upon which the learner constructs new learning. Some of this knowledge could be well advanced as the learner may have been engaged as an apprentice in a particular trade. Further, indigenous knowledge takes cognizance of sustainable and locally available resources. The use of such resources (including human resources) is important in developing sustainable solutions.

Active learning and Making encourages the construction of knowledge from prior knowledge. Indigenous ways of knowing (or indigenous funds of knowledge) are an excellent source of prior knowledge. Learners come to school with a bank of indigenous ways of knowing that represents their community's way of life. The knowledge includes: folklore, artifacts (tools, art, crafts), environmental resources (plants and animals), learning systems, taxonomy, laws, equipment, forms of communication and organization. The folklore, for instance, would provide a good starting point for various linguistic literacy competences while artifacts and equipment would inspire relevant creativity and aesthetics for new or modified designs. Taxonomies and environmental resources would be a good starting point for mathematical and scientific literacies. In addition, the prior knowledge would be key in determining what is contextually relevant and appropriate, an important consideration for sustainable innovations and interventions.

A recent example of the importance of indigenous knowledge occurred in August 2017 and impacted butterfly farming in rural Tanzania. Butterfly farming is important to local economies for the export money it brings into local communities. However, external production practices had almost threatened the extinction of butterflies. It was not until the minister for Natural Resources and Tourism in Tanzania consulted with local farmers that practices were returned to traditional ways of knowing and doing and the cultivation, harvesting and exporting of butterflies again began to flourish (*The Citizen*, 6 August, 2017).

In determining creativity, relevance and sustainability of solutions and applications, careful considerations has to be made of the context in which the learning occurs. Understanding indigenous sense of aesthetics, taboos, and cultural concerns.

Active learning draws on play, questioning and imagination (Thomas & Brown, 2011). As a pedagogical orientation, Making:

- Emphasizes collaboration, innovation, creativity and critical thinking;
- Is a process of problem finding and problem solving;
- Naturally leads to active learning – learners discuss, design and make things;
- Leads to learner engagement (intellectual, emotional, behavioral, social and cultural) – high levels of student engagement are evident when learners are inquisitive, interested and therefore motivated to pursue more learning;
- Is goal oriented hence very motivating;
- Renders both process and product important; and
- Ensures that the learning is in the process

Active learning requires learners to collaboratively co-construct knowledge in ways that are contextually relevant and appropriate. It encourages students to gain new knowledge and /or modify it, use it, and reinforce existing knowledge. Active learning requires students to engage in a process of constructing (making) meaning of their world. Students do not merely imbibe knowledge given to them by teachers reading from textbooks. Active learning means students are presented with opportunities to construct knowledge individually and collaboratively.

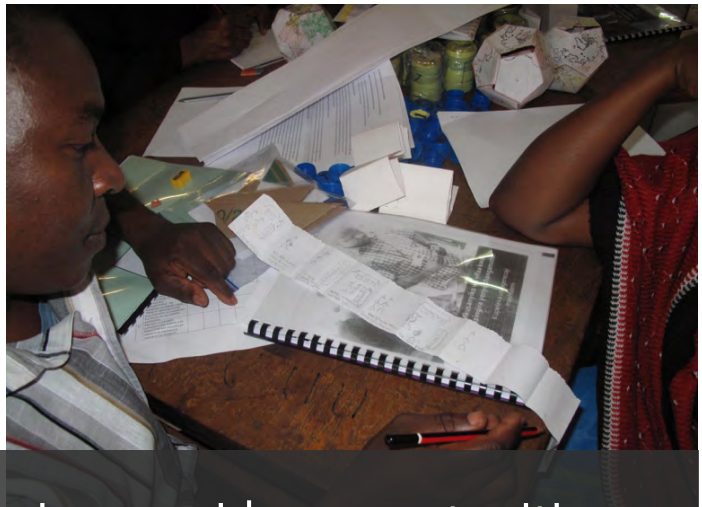
In order to do this, teachers must begin to embrace and fully understand the following beliefs:

- Learning should be an active process - the learner uses sensory data to construct

knowledge (this recognizes multiple intelligences as sources of sensory data)

- Learners learn to learn through constructing meanings and systems of meaning – creating some order – patterns, classes, groups, chronologies
- Construction of meaning has to be both a physical and cognitive engagement and involve some physical representation of one's meaning together with explanations of the choices we make and why
- Language is a crucial aspect of learning – we make meaning in the language that we are most comfortable with hence the importance of choosing, for instance, a local language for instruction or expressing learning
- Learning is a social activity - traditional education tended to isolate the learner, progressive education recognizes learning as a social endeavor (social constructivism) where learners work collaboratively to co-construct knowledge which is meaningful in a given context
- Learning does not occur in a vacuum – it is contextual- hence the need for contextually relevant and appropriate knowledge. Imported 'knowledge' may not be relevant or appropriate thus losing the 'value' of being regarded as knowledge in the target context.
- Learning requires knowledge - there is need for the facilitators and learners to draw from prior knowledge. For instance, indigenous knowledge is a great source of prior knowledge that informs new knowledge construction because it is contextually relevant and appropriate
- Learning takes time – it is not instantaneous. It requires planning, practice, reflection and revisiting- new insights and understanding occur during these phases.
- Learning requires motivation - learners need a reason to want to learn. The learning process and the product (the new construction) provides motivation to learn and then want to learn more.

When teachers teach in active, student-centred ways, they create opportunities that allow the students to learn through a process of experiencing and making things and then reflecting on those experiences. These experiences foster deeper and longer lasting understanding.



Active Learning provides opportunities for students to visualize their learning

1.5 Making and East African Education

East Africa, like other developing global economies, aspires to transition from a low income to a middle-income economy. In order to achieve this, it must continue to reform its educational policies. The most recent changes has been reviews of curriculum in an effort to make them more skills and competency based. It is important to note that while East Africa, collectively, has recorded remarkable achievements in providing access to basic education over the past 10 years, there has been a steady slide in the quality of education, begging the question of whether the children are learning or simply attending school (MoESTV, 2016: World Bank report July 2014; UWEZO reports 2011-2014). The World Bank, Canadian Development Fund and other development partners in East Africa target to improve learning outcomes by addressing specific concerns found to contribute to the poor learning outcomes.

Specifically, with regard to learning, these groups propose to ensure:

- Teachers are motivated to spend more time in class teaching
- Teachers are well-trained
- There are enough teachers for all students and schools
- Data are gathered and results monitored regularly so that education is managed more efficiently
- More students learn to read, write and do basic math by the end of grade 2 (World Bank, 2014)

While steps have been taken to isolate what needs to be done, the actual process of motivating and supporting teachers, engaging learners and gathering data is a pedagogical issue. The proposed pedagogical orientation, Making, offers some practical solutions to how these noble targets could be met. Through Making, the teachers can have reasons to stay longer in class and the students will be well engaged; there are many opportunities for gathering data that evidences the learning process and provides authentic data for both formative and summative assessment. That data can then inform school management and other stakeholders on both achievements and areas that require attention and provide a process that develops both literacy and numeracy in practical and evident ways. Ultimately, the process of Making creates opportunities for meaningful learning for both the teacher and the learner that is both contextually relevant and able to empower quality education.

Making supports pedagogical changes that include collaborative learning and problem finding and solving competencies that are valued in new curricular initiatives. Making, through its incorporation of design thinking, working together, finding and solving problems enhances the development of new kinds of literacies that develop communication, arithmetic and collaborative skills. Through making, teachers and students are able to tangibly integrate their learning in reading, writing and arithmetic.

Research studies show that the curriculum was typically overloaded with too many subjects, requiring teachers to overemphasize the teaching of subject content and putting less emphasis on the development of basic skills and competences in Reading, Writing and Arithmetic, necessary to effectively learn content (MoESTV, 2016). To solve this problem governments have designed new, integrated curriculums that focus on skills and competencies in an integrated manner rather than content and distinct subject disciplines. The focus on skills, competencies and an integrated approach to learning is at the very heart of Making and design as a pedagogy. Making and design adopts a holistic approach to learning that is independent of any one subject. Its focus is on building skills and competencies as a way of learning that is very much linked to the day-to-day contextual realities that students experience.

Good design can be described with ten principles (Vitsoe, 2013). They Include:

- Good design is innovative
- Good design makes a product useful
- Good design is aesthetic
- Good design makes a product understandable
- Good design is unobtrusive
- Good design is honest
- Good design is long-lasting
- Good design is thorough down to the last detail
- Good design is environmentally friendly
- Good design is as little design as possible.

1.6 Making and Design Thinking

Making is an excellent way of providing evidence of the cognitive processes that occur during learning. Making requires teachers and students to actively design and build meaning using low cost or no cost materials and resources. The first step in Making is the design thinking process.

"Design thinking is generally considered the ability to combine empathy for the context of a problem, creativity in the generation of insights and solutions, and rationality to analyze and fit solutions to the context" (Wikipedia, n.d.). It is a human-centered design process that considers the user rather than solely the problem, potential product, or outcome.

Design thinking is a significant part of Making. We have observed that if teachers or students are given a problem to solve, they tend to rush to one solution without considering all the confounding variables and potential solutions. They often make what they already know and miss the opportunity to innovate and be creative.

Design thinking allows us to share our views about particular issues, and through dialogue expand our ideas. Dialogue reveals our thinking and consider alternatives. Using a design thinking process, we can thinker (think and tinker) and engage in purposeful play. It allows us to talk collaboratively in groups while considering, discussing, researching, and exploring options. This is often called *lateral thinking*, a kind of thinking that tends to foster creativity and innovation.

Design thinking aligns nicely with Making by helping makers consider what they would like to create and what might be needed. The process of design thinking involves a series of decisions and activities that inform the designer. Children enjoy working with ideas and turning those ideas into tangible things.

Although design is always subject to personal taste, design thinkers share a common set of values that drive innovation: these values are mainly creativity, ambidextrous thinking, teamwork, end-user focus,

curiosity (Wikipedia, n.d.).
Design thinking is a process for solving problems. Typically, it consists of seven steps:

Define
- Decide what issue you are trying to resolve
- Agree on who the audience is
- Determine what will make the project successful

Research
- Review the history of the issue; try to determine why is it a problem
- Collect / share examples of other attempts to solve the same issue
- Talk with people who share or who have encountered this problem

Ideation
- Identify the needs and motivations of your users
- Generate as many ideas as possible to serve these identified needs
- Sketch as many ideas as possible
- Do not judge or debate ideas
- During brainstorming, have one conversation / interview at a time

Prototype
- Combine, expand, and refine ideas
- Create multiple drafts
- Seek feedback from a diverse group of people, include your users
- Share your prototype with others
- Reserve judgment and maintain neutrality
- Create and present actual working prototype(s)

Choose
- Review the objective
- Set aside emotion and ownership of ideas
- Avoid consensus thinking
- Remember: the most practical solution isn't always the best
- Select the powerful ideas

Implement
- Make sample descriptions

Execute
- Test your idea with your users

Learn
- Gather feedback from the user(s)
- Determine if the solution met its goals
- Discuss what could be improved
- Measure success; collect data
- Document

Increasingly teachers are called upon to be designers of learning experiences. This is a shift from their previous roles as implementers or interpreters of curriculum. A good way to incorporate design thinking in the classroom is to use it to help students intentionally find linkages between authentic learning experiences and curricular problems.

Teachers who are familiar with the design thinking process can work together to design and create resources that support their students' learning. The design thinking process is described in depth in the resource ***Toolkit for Challenging Contexts: Taking Making into Schools*** which is available in both English and Kiswahili ((*https://issuu.com/ubcedo/docs/toolkit4cc_english* and *https://issuu.com/ubcedo/docs/toolkit4cc_kiswahili*).

Design thinking allows teachers to work together and use a human centered approach to consider the types of resources and learning materials will best support specific students in their classrooms. A design thinking approach allows teachers to focus on learner needs and create resources that culturally relevant, contextual possible and gender appropriate.

Because of its emphasis on empathy, design thinking invites teachers and students to focus on human centered design and think about things worth

considering. It aligns nicely with STEMx projects grounded in improving the human experience. It requires students to develop their basic literacies (reading, writing and mathematics) in increasingly complex ways. Globally, teachers should incorporate the process of creative thinking – imagine, create, play, share, reflect (Resnick, 2007) in their practices as it reflects how children learn outside formal educational settings such as school. Typically, children learn through play and exploration. This is core for a pedagogy of promise as it encourages exploration and risk taking.

Rooted in constructionist theory and practice, Making is an excellent way of providing evidence of the cognitive processes that occur during learning. At various stages of the design thinking process, there is an overt representation of the thinking process. From the outset, teachers and students can share their views about particular issues. Through dialogue, they envision the concern shared by a partner. Then through a process of gaining empathy, they can seek to develop some solutions. Dialogue reveals thinking and articulates the thinking and the suggested solutions (in sketch and annotations) surfaced during the problem solving process – a response to the articulated need. Further negotiations provide evidence of mental assessments of the suggested solutions. The final sketch is evidence of collaborative thought. The prototype is the tangible evidence of the process of thinking. Final self- and peer-assessments, articulated in the reflections, provide evidence of the congruence between the initial concern shared and the solution presented. (See Section 2 *Making the Connections – Learning In Active Ways*).

1.7 Making Learning Visible – Assessment as Evidence of Learning

Assessment is an integral part of curriculum. Essentially, assessment should co-occur with teaching and learning during instruction. In the Making process, assessment serves as a driving force that keeps the Making on track and ensures that there is evidence of learning (or lack of it).

Formative assessment, also referred to as *assessment for learning*, is what moves the process from one step to the next. Whether conducted by self, peers or facilitators, formative assessment contributes to the completion of the project. Formative assessment is carried out when the learners share their thoughts, sketches and engage in the process of developing the prototype. During this period, the teacher can monitor and scaffold learners to ensure that they get good results. Formative assessment contributes to the production of the prototype that is then summatively evaluated by self, peers and facilitator during the sharing of prototypes. The physical product, sample description record can be availed for further assessment and as evidence of the learner's competence. For more on Assessment strategies, please see Section 4 *Assessment - Reimagining Ways to Value Process, Product, Creativity and Active Learning*.

Formative Assessment contributes to the completion of the project.

Rethinking and Reusing: Using the tops of water bottles as letters and numbers for literacy activities

1.8 Making a Sustainable Future – Adding 4 R's for Living to Our Basic 3 R's

Active learning, design thinking and Making allows us to see our local environment in different ways. Often, many of us in challenging contexts are tempted to stall and dwell on the things we do not have and adopt a deficit mindset. We tend to become passive and wait for others to fix our situation by bringing resources from elsewhere or stall in our activities hoping more money or materials will appear. A growth mindset allows us to see what we have rather. For more on fostering a growth mindset, please see Section 2 *Making the Connection – Learning in Active Ways*. As the US President Barack Obama said so beautifully, "Change will not come if we wait for some other person or some other time. We are the ones we've been waiting for. We are the change that we seek."

To step up into the role of change agent, educators have the important task of introducing their students and community to the Four R's of global citizenship – the ability to rethink, reuse, reduce and recycle. Too often our communities are cluttered with discarded waste items and litter.

Rethinking includes the ability to look at potential waste items and imagine an additional use for them before they are recycled. Please see Section 9 *Sample Resources* for suggestions of classroom resources that use discarded materials in the creation of learning resources. An example of Rethinking is the use of plastic bottle tops as a Math Manipulative to foster basic numeracy and mathematical thinking.

Reusing includes the ability adapt or modify an existing item for another purpose. Examples include the letter blocks shared in Section 9. Paper, plastic, or cardboard are great reusable materials. Imagine collecting and laminating together discarded, unwearable flip flops. When glued together, flip flops provide a sturdy stack of plastic that can be carved into shapes in the same way you might carve wood. This approach provides inexpensive carving materials. It also addresses the issue of discarded plastic sandals polluting our oceans and waterways.

Art project from discarded flip flops. More examples: www.facebook.com/greensteps.tz

Making a Sustainable Future …

Adding 4Rs of Living with Basic 3Rs of Schools

What we do to our environment is a reflection of what we do to ourselves and others.

~ Mahatma Gandhi

Sparking your imagination

Consider the following uses for recycling plastic bottles. Imagine making a boat by connecting plastic bottles together. Imagine using bottles to make insulated walls for a small building. The insulation comes from putting water or sand or dirt in the bottles before the walls are assembled. These ideas come from http://ecoadmirer.com/30-cool-things-to-make-using-plastic-bottles/.

Reducing our consumption of materials is also important. We have facilitated workshops in which participants cut small pieces of paper from large sheets, often wasting the remaining sheet. Could pre-thinking and planning help us to reduce the amount of materials we use? Could we store and reuse the left-over pieces? As we finish our work, do we look at what is left over, or do we simply finish our work and walk away, leaving waste for others to sweep away?

Recycling includes our ability to think what happens next to the waste we have generated. Typically, we simply discard materials or burn them, thinking they no longer serve a purpose. However, we know that burning plastic is toxic and the fumes and ash are hazardous. Locally, can we form organizations / groups to consider local recycling and see if there might even be an economic benefit?

The scarcity of teaching and learning resources is increasingly recognized as an impediment to improving the quality of education in East Africa. Therefore, there is a need for focusing on utilization of cheap, readily available, local materials and traditional toys and technologies that can be used as teaching and learning materials and support active learning. Similarly, there is a need to look for ways of reusing, adapting and recycling existing materials so that they can be used for longer. The advantage of this approach:

- It makes resources affordable for schools in challenging contexts
- It adopts resources in the students' context
- It allows longer and more diverse use of resources
- It uses resources that allow mastery of skills, transferability of learning
- It uses resources that allow for differentiated support for students at different learning levels

The use of local teaching and learning resources provides an opportunity for students to use and make resources that lead to better learning of otherwise often abstract concepts. Such engagement with resources helps students to master basic competencies of reading, writing and arithmetic – the 3Rs - as envisaged in the renewed East African curriculum.

Introducing the 4R's of rethinking, reusing, reducing and recycling into our teaching helps to foster a more environment, green oriented mindset. The 4R's help us to reuse materials that we might previously have considered to be trash. Very simple steps like reusing bottle caps as letter blocks or manipulatives for counting are a start. Students can use caps for letter recognition and word formation. Students can show their understanding of addition and subtraction by creating their own Math problems such as 5 subtract 3 equals 2. The use of tangible materials helps students make their thinking visible in tangible, concrete ways.

A good rationale to foster a green mindset for ourselves and our students includes the following:

- A clean environment is essential for healthy living.
- Global warming is a concern and impacts all of us, everywhere.
- Looking after where we live, work and play is an investment for the future and a proactive way to live positively in the world.
- Biodiversity is essential – human activity and pollution impact everything. We live in an ecosystem. All creatures large and small need to have a place to flourish. A clean environment is a reflection of your character.

The final point might be the most important point. How we see ourselves is reflected in our actions. There is a saying that if we look after the little things, the big things will look after themselves. The addition of the 4R's for living, along with a focus on the 3R's for learning is a proactive start for children and a way to help them become responsible for their learning and their environment. Taking making into our classrooms lets us use and reuse materials for meaningful and useful teaching and learning.

As a pedagogical orientation, Making brings meaningful and useful teaching and learning into classrooms

Taking Making into Classrooms offers ways to foster curiosity, imagination and active learning.

Active learning requires teachers to

- Become resilient and comfortable with trial, error, mistakes and re-starts
- Become curious and help their students to become curious
- Work smarter and maybe even a little harder
- Embrace ambiguity and uncertainty
- Become increasingly tolerant and patient

Why?

If we ask our students to take risks and explore and become curious, we, as teachers, must be willing to do the same thing!

Section 2: Making the Connection – Learning in Active Ways

2.1 An Introduction to Making and Curriculum Reform

Locally and globally, teachers recognize the need to make learning more authentic, engaging and experiential. They are beginning to understand how design and making can play a significant role in educational reforms. *Taking Making into Challenging Contexts* offers ways to foster curiosity, imagination and active learning. The ideas in the toolkit align beautifully with what we know about teaching and learning. As teachers shift from traditional ways of direct instruction that encourages students to memorize facts (typically, rote learning) to newer ways of student centred, active learning, they help students to learn

1. How to learn – process
2. What to learn – facts and concepts
3. Why to learn – curiosity to learn more

These three parts of active learning put pressure on teachers to teach differently and use resources to promote active student engagement with core concepts, challenging ideas, and real world issues that impact us all.

2.2 Why Taking Making into Classrooms in Challenging Contexts Is So Important

While education has been touted as a key to positive transformation of the individual and the community, it can only attain this function if it is delivered in the right way. As observed earlier, the mind numbing repetitive actions of teacher-centered delivery do not necessarily result in learning. Teaching and listening do not automatically result in learning. Transformative learning requires active learning where the learners modify their meaning schemes by critically reflecting on their experiences. A first step is to create a conducive learning environment that allows the learners to experience, critically reflect, and make meaning of their experience. Making has been shown

What Active Learning Looks Like

to lead to active learning that is transformative. Making in the school context presents a great opportunity for transformative learning where the learners can critically contemplate issues in their context. Learners can engage in inquiry and articulate what they perceive as issues worth addressing. Through dialogue, they empathetically negotiate solutions and design and create solutions. Throughout this process, the learner takes a lead in the activity while the teacher facilitates and offers guidance through informally assessing progress. Both the teacher and the learners learn from the process, articulate their understanding by co-designing and co-creating solutions. This learning can be well documented through the steps carried out and also evidenced in the solutions created.

Students can be involved in the making of their own learning resources, especially when we are introduced to low cost or no cost locally available materials. As mentioned in Section 1.8, those materials can be found, recycled, or reused materials that can be purposed. Please see Section 9 for Sample Resources that suggest ways in which students can make hand puppets for storytelling using fabric scraps from local tailors or Tangram puzzles made from small pieces of discarded cardboard to develop their geometry skills. Making and using resources is an act of transformation. It transforms abstract ideas about concepts into concrete, tangible objects that can be used, shared, shaped, and modified to support active learning. This act of transformation helps teachers to take theoretical ideas and concepts and make them practical and real within a student's actual context.

Context is an important parameter in determining what constitutes quality education. While the general parameters are global, the details are context-dependent. As such, ideas about achieving quality education have to be contextualized so as to be successful. As stated in Section 1, challenging contexts are everywhere. Making has been successfully experienced in various educational contexts, including challenging contexts (i.e., aboriginal reserves in Canada, rural villages in East Africa). In these contexts, the general process remains the same - emphasizing the design thinking process and making. In many settings, a dedicated makerspace has been created to enable teachers to come together and imagine the future of education by reflectively engaging in design thinking and innovatively creating resources to respond to pedagogical challenges in their context (Please see

Section 9 and 10 for suggestions). Making together helps builds teachers' capacity to imagine and implement educational reform. It also allows teachers to share best practices and great ideas.

2.3 Making a New Culture of Learning within the East African Context

The renewed curriculum that is impacting the majority of schools in East Africa is an important response to achieving the United Nations Millennium Development and Sustainability Goals. It creates opportunities for non-academic children to gain success in our classrooms. This is an important point when we consider that fewer than 40% of our youth continue beyond primary education or enter post-secondary institutions. It helps us to begin to answer the question, what actually becomes of our youth who, for a variety of reasons, leave school? What skills do they need to make East Africa a vibrant and participatory member in a global world? Might making in classrooms help to enliven learning and support learner retention, interest and curiosity? These are just a few of the essential questions facing teachers around the world.

As stated in Section 1, East Africa, like other developing economies, aspires to transit from a low income to a middle-income economy. In order to achieve this, it has revised its curriculum because education is considered a strategic agent to providing impetus for development, growth and change.

In recent years, there has been much focus on the learning sciences. Through brain research, we know how children learn. Research from one of the world's leading universities, Stanford, suggests that when we tinker with complicated and engaging tasks and make mistakes and encounter failure we do the intellectual wrestling that fosters the development of brain synapses that actually builds brain plasticity and intelligence. Jo Boaler, working with students to build mathematical understanding, has learned that effort and practice grows the essential plasticity that supports deep learning and allows students to become more resilient and less frustrated when they make the necessary mistakes that support real learning rather than rote memorization.

Another researcher at Stanford, Carol Dweck, researches the idea of a growth mindset. She suggests that a growth mindset differs from the more traditional idea of a fixed mindset. A fixed mindset suggests there are things that we can and cannot do well. A growth mindset suggests we can grow our capacities by wrestling with problems worth thinking about and continually learning. While students might not become experts in every subject, they can become knowledgeable and better at the very act of learning – a skill that will serve them well throughout their lives and well beyond their school years.

Developing a growth mindset, fostering creativity, and engaging in design thinking are all components to a pedagogy of promise; one that is optimistic and seeks the good in learning situations and the positive

Teachers require time to discuss ideas and opportunities to make the resources required to support active learning

Fixed and Growth Mindset Work of Carol Dweck, Stanford University		
FIXED MINDSET	**MINDSET CHARACTERISTICS**	**GROWTH MINDSET**
Intelligence is static. Traits and Skill Sets are what you are born with and you have to live with – You have what you are born with	**INTELLIGENCE AND SKILLS**	Intelligence can be developed. Traits Skill Sets can change through application and experience – You can grow and develop traits and skill sets
Focus is on **Performance** leading to a desire to *look smart*	**MAIN CONCERN**	Focus is on **Learning** leading to a desire to *improve*
Consider effort as something you do when you are not good at something	**EFFORT**	Consider effort as a path to mastery by learning and deliberate practice
Challenges and obstacles are avoided whenever possible. If necessary to address a challenge or obstacle, gives up or checks out as quickly as possible	**CHALLENGES AND OBSTACLES**	Challenges and obstacles are minor setbacks requiring perseverance to work through fostering grit and resilience.
Feedback may be taken personally resulting in a defensive attitude, ignoring useful constructive feedback, blaming others or expressing excuses	**FEEDBACK**	Feedback is necessary to grow and develop.
Experiences are used as confirmation of intelligence, skill sets and traits. Mistakes are avoided by using what has been used before and hiding deficiencies	**MISTAKES**	Experiences are used as learning opportunities to develop intelligence, skill sets and traits. Mistakes are part of the learning processes.
Success of others may surface feelings of possible threats or some kind of loss – focusing on competition	**SUCCESS OF OTHERS**	Success of others may surface feelings of inspiration and lessons to learn – focusing on collaboration
People using fixed mindsets are likely to • Plateau and achieve less than their full potential • Avoid risks • Devalue effort because they feel their abilities are pre-determined	**RESULTS**	People using growth mindsets are likely to • See value in challenging themselves • Engage in risk assessment and intellectual risk-taking • Value effort because they feel their abilities may grow and develop

development of individual capabilities. A mindset is the beliefs and attitudes we all hold about the world around us and our own capabilities.

A growth mindset can support our curiosity and ambitions and motivate to do more and try more. A fixed mindset can hold us back and limit our possibilities. As teachers, we can hold fixed mindsets about our students and believe that boys could never write good poems or girls could never do math. With a growth mindset, we can be optimistic and embrace the challenges in front of us with confidence to try. The resilience to learn from errors and try again with renewed energy and information is at the heart of active learning and Making.

Globally, teachers are coming to realize that making helps to foster a growth mindset and enables the type of learning environments that are

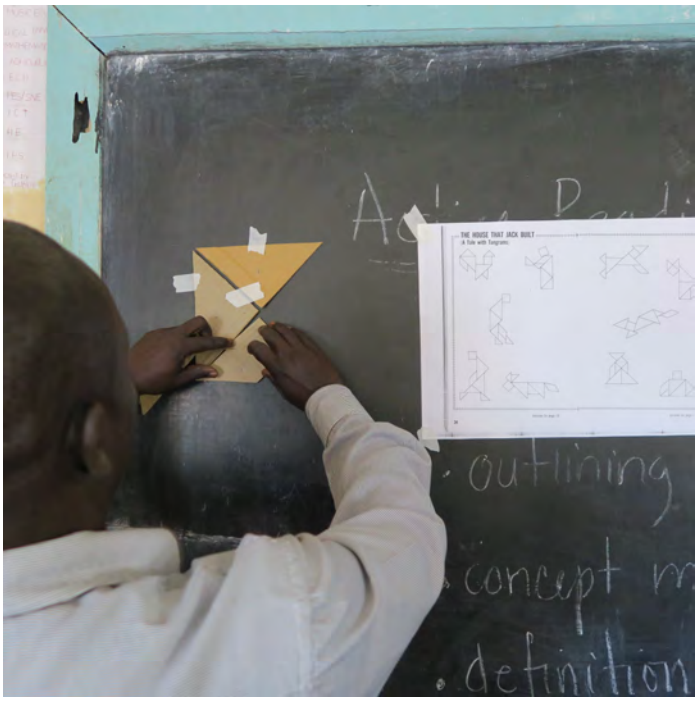
- Student centred
- Structured and well-designed
- Authentic
- Inclusive
- Collaborative and social
- Creative
- Supportive of problem finding and problem solving
- Supportive of continuous skill development
- Supportive of critical and creative thinking

2.4 Fostering an Intentional Mindset – Central to a Teacher's Work

When teachers take Making into their classrooms, they must foster an intentional mindset that includes designing, Making, engagement and curiosity. *The Toolkit for Challenging Contexts: Taking Making into Schools* offers suggestions for facilitating immersive professional learning experiences for teachers so they can experience the value of design and making before they introduce it to their students. You can obtain a copy of that toolkit from https://issuu.com/ubcedo/docs/toolkit4cc_english and https://issuu.com/ubcedo/docs/toolkit4cc_kiswahili)

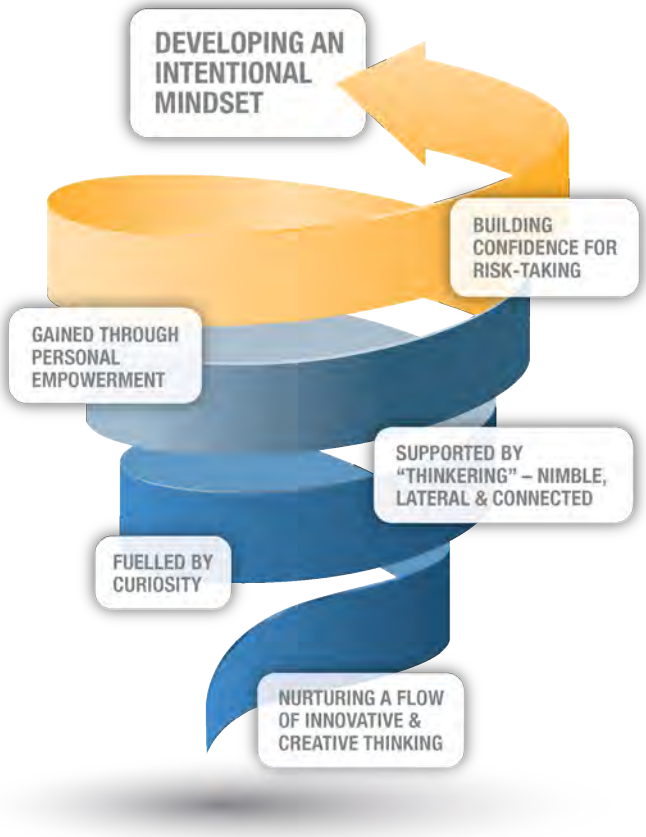
Once teachers are comfortable with Making, they can introduce similar immersive experiences to their students, helping them to develop intentional mindsets. By embedding Making across curricular areas, teachers create opportunities for students to experience Making and nurture innovative and creative thinking through design and tinkering. The resources shared in Section 9 are provided to help teachers imagine what locally developed resources for challenging contexts might look like and how to make them. Suggestions as to how to make resources is provided in Section 3.

An intentional mindset connects the curriculum to the student learning. It provides the answer to the question – how is a particular concept or idea being taught? As stated earlier in this section, as teachers



Making fosters an intentional mindset including designing, Making, engagement and curiosity

shift from traditional ways of teaching, they help students learn *how* to learn, *what* concepts and ideas are essential to learn, and *why* they might want to learn more about the world around them. When teachers think intentionally about how, what, and why of learning, they invite their students into the world of possibly and creative imagination! Teachers begin to create exciting learning environments that are support of growth, risk taking and experimentation. They remind their students that innovation and new ideas typically come from hard work and trial and error – through a resilience to stay the course and learn no matter the challenges and frustrations. A real story that is helpful to understand the idea of intention, growth and resilience is the story of Thomas Edison, the inventor of the light bulb. The invention of a long-lasting light bulb did not come easy, and many people asked him how he coped with so many "failed" attempts to get it right. Edison's answer the question of failure was, "I have not failed. I've just found 10,000 ways that won't work." Working through 9,999 attempts and staying the course to the 10,000th successful one is a good example of persistence, resilience and a growth mindset motives a person to achievement.



An Intentional Mindset Spiral, Work by Dr. Susan Crichton

Teaching with intentional and growth mindsets

- Require teachers to be patient with the learning process and the learners
- Motivates teachers and students to learn and continue to learn
- Encourages continuous development
- Fosters curiosity
- Foster creative imagination
- Allows mistakes and trial and error to be an expected and intentional part of the learning process
- Uses resources to scaffold learning and promote active engagement

By introducing students to quality learning resources and then facilitating them through a design phase, students can be encouraged to nurture innovative, divergent, and creative thinking. Design thinking and quality resources prompt curiosity and help students to think laterally and find connections amongst ideas generated by others. Teachers must be intentional in their development and use of resources if they are move beyond teacher centred, direct instruction. If the resources are developed for the teachers' use, little will change in the pedagogy and the learning will remain passive rather than active. The quality resources can be used to nurture the flow of innovative and creative thinking in students thereby flowing their curiosity and creative thinking. The graphic below illustrates the recursive nature of experiences needed to building an intentional mindset. When students and teachers have an intentional mindset, they know why and what they are learning and they can begin to explore and take risks. It is with an intentional mindset that a growth mindset is developed!

One of the most important ways to foster an intentional mindset is to regularly engage in professional reflection. Reflection can be a reality check.

Guided reflection focuses thinking and helps move teachers forward in growth oriented way. The following steps might help teachers use guided reflection to inform their teaching and use the refection for professional and personal growth.

1. Describe the teaching activity you want to reflect on. Summarize the steps and the intention of the teaching.

2. Ask, what is my reaction to the activity? How do I feel about it and my students' reaction to it?

3. Evaluate the activity based on your intention and the student response.

4. Analyze the steps involved in the activity. Think about the activity in small parts rather than the entire activity. What worked, what could have been better, what else was needed, how was the resource, how did the students respond, etc.

5. Conclude this reflect with planning next steps. How might you do this activity again? How can you build on this activity in the immediate future?

Guided Reflection helps to focus thinking

Notes

Well-crafted Local Making Resources foster rich active learning, support the development of multi-literacies, and enable an intentional growth mindset.

Well-crafted Local Making Resources allows teachers and students to engage in purposeful play through problem finding. Students are invited to tinker, thinker, and reflect on ideas, concepts, materials, and data.

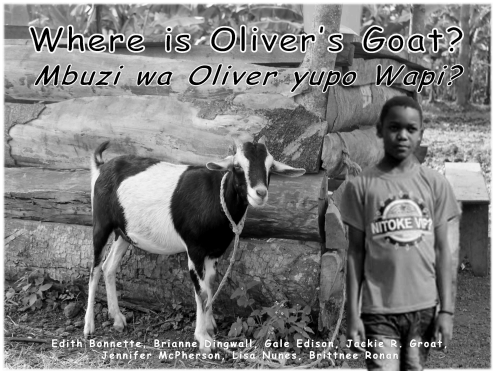
Section 3: Using Local Making Resources to Promote Active Learning, Purposeful Play and Hard Fun

Resources position learning within a particular context. Local Making resources invite teachers and students to engage collaboratively in Design Thinking as a process to define the learning problem (problem finding) and begin to prototype solutions (tinkering). While Design Thinking is similar to the scientific method, it differs significantly in terms of its focus on empathy and human-centred concerns. The design thinking process used in *Taking Making Into Classrooms* modifies the five step approach honed at Stanford's d.School into a four phases (*design, tinker, thinker, reflect*). **Note:** Descriptions of the Four Phases are available in Section 5, *Taking Making Into Challenging Contexts: A Toolkit Fostering Curiosity, Imagination and Active Learning (*(https://issuu.com/ubcedo/docs/toolkitccresources_english_issuu)

Seymour Papert, the MIT educator and innovator who developed the pedagogy of constructionism, coined the phrase *hard fun.* He came to this phrase after listening to students as they worked. Students described their initial work as being fun and hard – hence *hard fun*.

Thus, a well-crafted Making resource provides students with something to engage with and think about. As Papert said, "You can't think about thinking without thinking about thinking about something." Resources provide provocations for design thinking and problem solving. Their creation and usage provides a process by which teachers and students engage in active learning, problem finding, questioning, and reflecting to develop a solution and then reflect on what might be next.

Well-Crafted Local Making Resources



When *Taking Making into classrooms*, we have the opportunity to create intentional active learning experiences that promote *purposeful play* and *hard fun*.

3.1 Structure of a Well-Crafted Local Making Resource

Well-Crafted Making Resources are thoughtfully and intentionally developed. They consist of eight integrated components. It is important to consider how students will use the resource to show their growing competency with a specific learning outcome. It is also important to remember that while the teacher might use the resource for demonstration purposes, ultimately the resource is for the students to use and possible to make the resources for themselves.

1. Title – Descriptive enough to explain the intention of the resource.

2. Resource Description - Short explanation of what the resource is and what materials were used.

3. Competence Addressed - Short explanation of what competencies the students are developing

4. Objective - Short explanation of what curricular learning outcome(s) the resource is addressing

5. Suggestions for Using the Resource in the Classroom - Short explanation of how students might actively engage with the resource

6. Detailed Steps - Detailed steps for making the resource, including source of materials

7. Suggestions for Assessment - Short explanation of how this resource can be used for various forms of assessment – informal, formative, summative. Please see Section 4 for Assessment suggestions

8. Tools and Safety Tips - Short description of the tools needed to make or use the resource and safety tips for using the tools

The table, *Making Resource Components, Descriptions, and Example* positions the eight components in an example of a well-crafted local Making resource, *Tangrams – A Puzzling Task*.

Making Resource Components, Descriptions, and Example

MAKING RESOURCE COMPONENT	COMPONENT DESCRIPTION	EXAMPLE: *TANGRAM MAKING RESOURCE*
1. **Title**	Descriptive enough to explain the intention of the resource	Tangrams A Puzzling Task - How 7 Shapes Can Form A Square?
2. **Resource Description**	Short explanation of what the resource is and what materials were used.	Tangram is a Chinese puzzle consisting of 7 pieces. The 7 pieces can be arranged to form a square. They can also be arranged to form other shapes or patterns. There is a story involving the origins of tangrams. Legend explains that a long time ago in China there lived a man called Tan. Tan's greatest possession was a fine ceramic tile. One day Tan was carrying his tile to show the Emperor. He tripped and the tile fell and broke into seven geometric shapes: two large triangles, a medium size triangle, a square, and a parallelogram. Tan spent the rest of his life trying to put the tile back together again. He was not successful, but he did succeed in creating many different geometric designs. Tan enjoyed creating the designs. His friends also enjoyed trying to recreate his designs. Tan's puzzles, later called tangrams, were passed on through generations and from country to country. Tangrams are perhaps the oldest and most enduring of all geometric puzzles.
3. **Competence Addressed**	Short explanation of what competency(ies) the students are developing	• Problem solving – How 7 pieces becomes a square • Logical thinking • Perceptual reasoning • Critical thinking – how to assemble pieces into a square; Extension activity includes, using the 7 pieces to make other recognizable shapes • Creativity – ability to create other shapes • Geometric shapes – naming the 7 shapes that make up the Tangram square • Tessellation – recognizing patterns and the importance of angles • Spatial literacy – developing skills to see shapes and patterns. It is how we navigate and read our world and is essential for map making

Resource Components, Descriptions, and Example		
RESOURCE COMPONENT	**COMPONENT DESCRIPTION**	• **EXAMPLE: *TANGRAM RESOURCE***
4. Objective	Short explanation of what curricular learning outcome(s) the resource is addressing	• Introduction to geometric shapes • Development of patience and resilience for problem solving • Development of visual and spatial awareness
5. Suggestions for Using the Resource in the Classroom	Short explanation of how students might actively engage with the resource	• Introduce the basic geometric shapes to students (square, triangle, parallelogram). • Give a set of tangrams to each pairs of students. • Ask students to form a square with the 7 shapes. Initially, after a time, you might have to provide tips to help the students solve the puzzle. • As an extension activity, give students other tangram shapes to try to make. • As a further extension ask students to create their own shapes using the 7 pieces. Invite them to challenge their peers with their designs. • Allow students to create their own tangram sets using Mathematics rather than simply cutting the shapes using your sets as patterns. The following are the Mathematical directions for creating a tangram set: 1. Make a square of any size 2. Bisect any two sides i.e. length and width 3. Join the bisected points to form an isosceles triangle 4. Place a ruler and make a diagonal line to the isosceles triangle and bisect its longer side 5. Draw the second diagonal on the same square 6. Measure the second diagonal and divide it into four equal parts 7. Join the first quarter to the bisection of the longest side of the isosceles triangle 8. Join the 3rd quarter to the starting point of the bisected isosceles triangle side.

Resource Components, Descriptions, and Example

RESOURCE COMPONENT	COMPONENT DESCRIPTION	EXAMPLE: *TANGRAM RESOURCE*
6 Detailed Steps	Detailed steps for making the resource, including source of materials	1. Make a copy of the master TANGRAM square. The square can be enlarged to any size you wish. Just make certain that as you enlarge the square, you retain equal length of each side of the square. 2. Carefully cut the square into its 7 pieces. It is important that each piece be exact with sharp corners and straight lines. 3. Copy each piece to cardboard or wood. This will make a durable set of TANGRAMS that you can reuse in your class. 4. Cut the cardboard or wooden TANGRAMS carefully. Possibly a local fundi could make wooden sets of TANGRAMS at a reasonable cost.
7. Suggestions for Assessment	Short explanation of how this resource can be used for various forms of assessment – informal, formative, summative. Please see Section 4 for Assessment suggestions	Informal Assessment • Observe the students as they work with the Tangram shapes; • Note the way they problem find, solve and communicate; • Note the collaboration and their capacity for trial and error; and • Offer coaching and support as they solve the puzzle. Formative Assessment Using a pre-determined checklist of competencies to observe the students growing skills and abilities; and Share with the students their grades against the checklist criteria and offer suggestions for improvement and growth. Summative Assessment • After practicing with the Tangram puzzles, assess the students' ability to make a set of Tangrams; • After practicing with the Tangram puzzles, assess the students' ability to form a square; and • After practicing with the Tangram puzzles, assess the students' ability to form other practiced patterns.

Resource Components, Descriptions, and Example		
RESOURCE COMPONENT	COMPONENT DESCRIPTION	EXAMPLE: *TANGRAM RESOURCE*
8. Tools and Safety Tips	Short description of the tools needed to make or use the resource and safety tips for using the tools	Tools Needed: Ruler or straight edge; and Box cutter or scissors. After you outline the Tangram shape on heavy paper or cardboard, use a straight edge or ruler as a cutting guide. If you are using a box cutter or small knife, remember to cut away from the hand holding the straight edge still. If you are using a box cutter or utility knife, remember to extend the blade of your knife only as far as necessary to cut through the cardboard. Always use some scrap cardboard or wood under the material you are cutting to avoid damaging the tabletop. Remember to cut slowly. Many smaller cuts are easier to manage than attempting to cut through all the layers of cardboard at once!

The example of the Tangram Making resource works well because it positions easily recognized shapes within the process of developing creative and critical thinking and fosters a deep understanding of geometric shapes, spatial literacy, and aesthetic formations. It is not a stand-alone activity! A Tangram learning activity supports spatial literacy, geometry, verbal skills and problem solving.

Active Learning is different from teacher directed learning. When we teach using active learning approaches, we begin to

- experiment
- engage in inquiry
- develop resources that support personalized learning
- create opportunities to develop social and emotional learning skills
- think about pedagogy and its relationship to learning objectives, curricular competencies, and assessment opportunities
- personalize the learning, fostering the growth and development of each student in our care

Many of us attended schools that had no resources to support our learning. We listened to our teacher and sat quietly. Depending on the lesson, we might have repeated what the teacher said, often in unison with our classmates. This type of learning is typically called *direct instruction*. The teacher directs the learning, treating a group of students as one. The lesson is shared and not customized or personalized for individual students. Typically, even abstract concepts are shared in this manner in a teacher directed classroom. The students are not given opportunities to make meaning from the concepts and show whether they have learned or not learned before the student continues with the lesson. Many of us teach today in similar ways in which we learned as students.

When we work to foster a pedagogy of promise, we assume that all the students in our care can learn. All students have a potential and the promise to become knowledgeable contributors to their families and communities. We use resources to engage the students in their learning so they can show us what they know and what they need to know.

The table, *Developing a Pedagogy of Promise and Potential: Using Active Learning to Support Student Success*, describes Active and Teacher Directed learning environments. The intention of the Pedagogy of Promise is to promote a better future for students and the development of a positive learning environment.

Developing a Pedagogy of Promise and Potential Using Active Learning to Foster a Growth Mindset and Support Student Success	
ACTIVE LEARNING	**TEACHER DIRECTED LEARNING**
• Instruction is Student-Centered	• Teacher directs the instruction
• Students collaborate to learn and create information	• Teacher gives the information for the lesson
• Students ask questions of teacher and one another	• Teacher does most of the talking
• Classroom is purposefully noisy	• Students are quiet during lessons
• Lessons are used to introduce the big ideas of a topic then resources are used by students to explore those ideas and develop competency	• Lessons are sequential and orderly
• Students can demonstrate their growing understanding through informal teacher observations, formative demonstrations of increased competency, and summarize making of resources and materials • Students have a variety of ways to show what they know and want to work on further	• Testing is used for summative assessment
• Curriculum is situated within the students' context – culture, geography, and practices	• Curriculum is the same across the country
• Students and their teacher uncover the big ideas and develop competency • Teachers do not have to know all the answers – teachers and students can learn together and foster each other's curiosity and interest in learning more	• Teachers cover the curriculum learning outcomes
• Resources are used by students to develop competency and demonstrate understanding	• Resources are used by a teacher as props or decoration to illustrate ideas

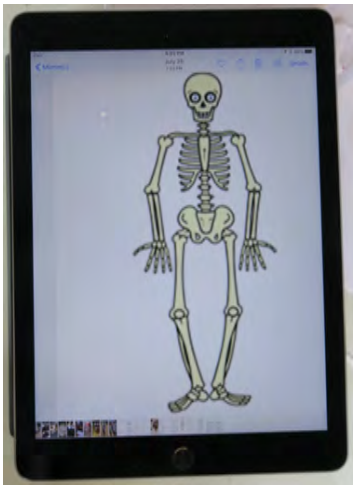
3.2 Asking More of Our Students – Purposeful Play and Hard Fun

When teachers teach using rote learning and direct instruction, students become passive and bored. Teachers who merely transfer information to their students actually ask too little of their students because there is little opportunity for students to ask questions or foster their individual curiosity about the concept or idea being presented. When teachers give students information, often all they ask in return from the students is a response with one correct answer. The process of transferring information actually makes the students PASSIVE.

Teachers often do this kind of teaching when they feel compelled to cover the curriculum, almost as if the students were not there in front of them. In this type of teaching, teachers are actually asking too little of their students! They are not giving their students opportunities to think, wrestle with ideas, foster curiosity and develop their own ideas or theories about the learning outcomes.

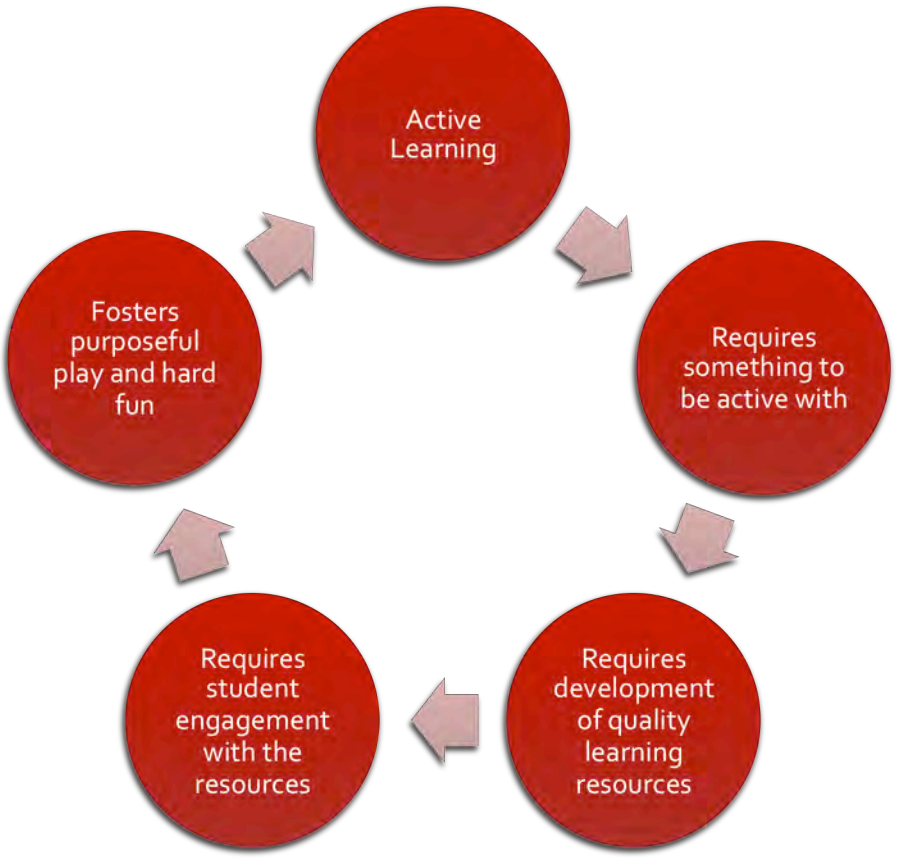
When teachers give students resources and ask them to design and make meaning, the teachers are working together with their students to uncover the important parts of the curriculum and develop intentional learning and develop a growth mindset to tackle more topics, concepts and ideas. This approach helps to engage the students actively in the learning process by using resources and asking powerful questions. The learning becomes more fun for both the teachers and the students because there is activity, questions, and movement. This type of teaching generates a special kind of energy that makes learning playful, purposeful and fun.

When teachers rush to cover the curriculum, typically they ask too little of their students. Memorizing content has been proven to be an impoverished way to learn and often leaves students struggling to know why they had to memorize it in the first place. This type of learning rarely stays with the student beyond the exam and has little impact on future learning. Research suggests that when students are given problems that are challenging and situated within their own context and prior learning, they will work hard to find the answers. If a resource is included, and students can explore the resource in an intentional way, they will begin to engage in purposeful play which results in hard fun!



Making is a meaningful way for teachers to introduce STEMx topics

Iterative Active Learning Process



Key to active learning is the creation of well-crafted local Making resources that

- are open ended and allow for various students activities and responses;
- are situated within two or more disciplinary areas;
- can be used to solve multiple problems and generate a range of answers and questions;
- can be used by small groups of students working collaboratively;
- build on previous learning;
- foster curiosity;
- are situated within the local context or environment;
- can be used to find a problem rather than merely solve a predetermined problem; and
- are cultural appropriate and reflective of the local context.

Section 4: Assessment - Reimagining Ways to Value Process, Product, Creativity and Active Learning

Traditional school based assessment tends to be product oriented. Teachers assess student learning in the form of tests or papers. When teachers introduce Making and use resources they are able assess the process of the students' learning and see how the students are making sense of specific learning outcomes. This approach allows teachers to assess for understanding and learning transfer. Teacher know that students truly understand when they

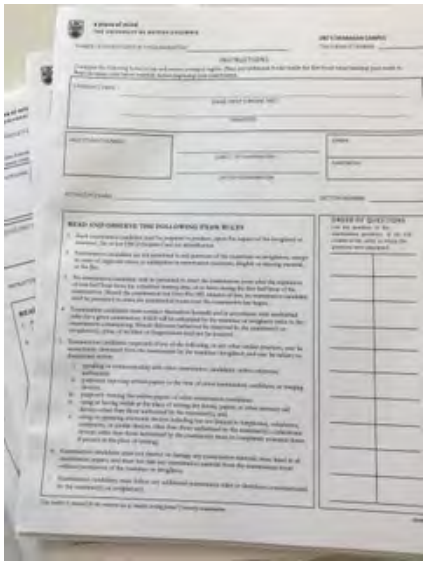
- Can explain concepts, principles, and processes by putting them in their own words, teaching it to others, justifying their answers, and showing their reasoning;
- Can interpret information for themselves by making sense of data, text, and experience through images, analogies, stories, and models;
- Can apply their learning by effectively using and adapting what they know in new and complex contexts;
- Can demonstrate various perspective by seeing the big picture and recognizing different points of view;
- Display empathy by perceiving sensitively and walking in someone else's shoes; and
- Have self-knowledge and can show meta-cognitive awareness, using productive habits of mind, and reflecting on the meaning of the learning and experience (Wiggins, p. 5).

Types of Assessment:

*Assessment **as** learning*
*Assessment **for** learning*
*Assessment **of** learning*

When we give students well-crafted local Making resources, we are inviting them to use their knowledge and skills to imagine alternative solutions to complex problems and concepts. We are inviting them to design alternative solutions and engage in risk-taking and critical / creative thinking. Each of these things we are asking students to do tend to be processes; and each process takes time to learn and master.

Types of Assessment



When teachers design and develop well-crafted local Making resources, they need to consider the types of assessment they wish to use. Typically, teachers think of assessment in three ways.

4.1 Types of Assessment

Teachers need to develop assessment tools that align with the learning intentions of their resources. This alignment allows teachers to make a fair and equitable assessment of student learning that might be demonstrated in a variety of ways. Fair and equal are challenging concepts, and open ended, project based learning really pushed teachers to think in different ways of how to be fair and accountable to student learning.

Assessment ***as*** Learning –

Informal Assessment that supports a student to learn more, make modifications, etc. It is aimed specifically at helping the student improve. It might be useful to think of Assessment as Learning as an ongoing, form of coaching. This type of assessment might be students assessing their peers or self-assessment using a checklist or rubric.

Assessment ***for*** Learning –

Formative Assessment or ongoing assessment that helps teachers modify their teaching and activities to support student learning. This type of assessment can be based on national standards or criteria referenced. Evidence is used to make a determination of a students' grade.

Assessment ***of*** Learning –

Summative Assessment typically done at the end of a unit or project. While it does little to improve student learning, it does provide a snapshot of a student's skills and abilities at a specific moment on a specific task.

4. 2 Assessment Ideas / Evidence

When teachers design a resource, they need to determine the type(s) of assessment they want to accomplish and what they will accept as evidence of student learning. Teachers might want to consider which if the following they might want to include as part of their assessment activities:

- Students' participation in the group problem finding and problem solving;
- Students' understanding of key concepts as evidenced in conversation with their peers and teachers as they use the resource;
- Students' understanding of specific content areas or curricular competencies;
- Students' understanding and abilities with developing skills and using the resource;
- Students' ability to ask good questions and reflect on their learning;
- Students' demonstration of creativity and imagination; and
- Other aspects identified in lesson outcomes or curricular modules.

4.3 Assessment Strategies

Teachers know that assessment practices are the tail that wags the pedagogical dog. If assessment stays the same (i.e., only summative or standardized examinations, etc.), then innovative ways of teaching and learning often become lost in the battle over what counts as learning. Making allows teachers to formatively assess process and summatively evaluate product. When students make and use learning resources, they provide their teachers with multiple forms and types of evidence of their learning. Therefore, a range of assessment strategies must be used. There are a variety of assessment strategies teachers might use.

Rubrics – used to assess performance along a continuum of competency and criteria. The criteria can be used to provide students as they complete their work and / or as an assessment tool for formative, peer and summative evaluation.

Checklists – used to record Yes / No observations of students' abilities against specific criteria. The criteria need to be written clearly and linked to specific learning outcomes, skills and abilities.

Rating Scales – used as numeric or criteria based noting of observations of students' abilities against specific criteria are assessment along a range. Scales can use language such as always, sometimes and never or fair, good, excellent or numeric values of 5, 4, 3, 2, 1. Criteria need to be written clearly and linked to specific learning outcomes, skills and abilities.

Anecdotal Notes – used to capture teacher recorded observations that are typically informal, short, and describe a student's developing understanding and participation throughout a lesson or unit. The notes focus on behaviours as well as skills and abilities.

Formative Assessment contributes to the completion of the project.

Observation Checklists – used to help teachers to make quick Yes / No observations of the what students can do, how they interact with others, and how are they progressing through the process of learning.

Portfolios – a purposeful collection of design notes, sketches, digital documentation, and other evidence that students are asked to collect throughout a unit of study. Portfolios are often assessed using a rubric.

Peer Assessment – student peers can use checklists or rubrics to assess classmates' work.

Self-Appraisal – students can use a framework to consider their own learning and achievement within or across specific or open learning outcomes.

A Sample Description, *Fun with Flight*, includes a rubric. This rubric was created using the free, online tool Rubistar (http://rubistar.4teachers.org/index.php). The rubric assesses 5 categories of learning outcomes across a 4 category scale of competence. Specific criteria is provided for each outcome.

Rubric for Fun with Flight

CATEGORY	4	3	2	1
Scientific Knowledge	Explanations by all group members indicate a clear and accurate understanding of scientific principles underlying the construction and modifications.	Explanations by all group members indicate a relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations by most group members indicate relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations by several members of the group do not illustrate much understanding of scientific principles underlying the construction and modifications.
Function	Structure functions extraordinarily well, holding up under atypical stresses.	Structure functions well, holding up under typical stresses.	Structure functions pretty well, but deteriorates under typical stresses.	Fatal flaws in function with complete failure under typical stresses.
Construction - Care Taken	Great care taken in construction process so that the structure is neat, attractive and follows plans accurately.	Constuction was careful and accurate for the most part, but 1-2 details could have been refined for a more attractive product.	Construction accurately followed the plans, but 3-4 details could have been refined for a more attractive product.	Construction appears careless or haphazard. Many details need refinement for a strong or attractive product.
Plan	Plan is neat with clear measurements and labeling for all components.	Plan is neat with clear measurements and labeling for most components.	Plan provides clear measurements and labeling for most components.	Plan does not show measurements clearly or is otherwise inadequately labeled.
Modification/Testing	Clear evidence of troubleshooting, testing, and refinements based on data or scientific principles.	Clear evidence of troubleshooting, testing and refinements.	Some evidence of troubleshooting, testing and refinements.	Little evidence of troubleshooting, testing or refinement.

Using a Well-Crafted Local Making resource, students are guided through four phases:

Design – Students gain empathy through questioning, interviewing and using the resource to explore.

Tinker – Students can test, refine fail, modify, and try again to make meaning. Students can work with resources to prompt good questions and conversations.

Thinker – Students are encouraged to make observations of the work of others and the use that understandings to tinker further, and modify and adjust their initial ideas. Thinkering combines tinkering and thinking.

Reflect – Students are given time to consider what they have done, what could be done, and to muse about the process / product / next steps. Reflection is the prompt for iteration and is essential to understanding that design thinking is a process (journey) not merely a product (destination).

Section 5: How Students Might Use Resources to Support Their Learning

As explained in Section 3, *Using Resources to Promote Active Learning, Purposeful Play, and Hard Fun,* well-crafted local Making resources can promote active learning, purposeful play and hard fun. Resources can be used by students to make their learning active. When teachers adopt a pedagogy of promise, they ***teach less*** and encourage students to make meaning for themselves and to gradually ***learn more*** than they would through rote memorization of facts and concepts.

While many classrooms in challenging contexts do not have the materials to print design thinking sheets for their students such as those shared in the teacher resource – *Toolkit for Challenging Resources: Taking Making into Schools*, students can be introduced to design thinking when they are use teacher made resources or make resources of their own. Section 9, *Sample Resources*, offers sample resources to support active learning. By using a good resource as a prompt and extending the amount of time for tinkering and thinkering, students can experience the four-phase model: Design, Tinker, Thinker, and Reflect.

5.1 Design

We define design as a problem finding experience that uses the design thinking process and is typically promoted by a Design Challenge. Design precedes making (tinkering).

The design phase helps the students to consider a resource from a variety of perspectives and to gain empathy for why it is important to the understanding of the big idea or concept within the curriculum. By gaining empathy, students discover why the big ideas or concepts are worth spending time exploring and why their first, potentially obvious solution might not be the best. Design

thinking supports a human centred approach, positioning empathy and understanding ahead of solutions and results. By itself, design thinking is an important skill for children as it allows them to see options and opportunities and design alternatives to existing situations.

Design thinking allows students to

- Integrate their thinking across subject areas and disciplines,
- Foster resilience and persistence through supportive design and tinkering iterations,
- Support thoughtful risk taking,
- Improve their life experiences and life chances by using their capacities and creating possibilities, and
- Make meaning by helping them to see relations and make connections between often disconnected facts / information and situations.

Design thinking, as a process, encourages students to develop an optimistic stance toward complex problems. When we introduce students to design thinking, it provides them with a way to see how things might be different and to feel that there is a way to make things and then make those things better. *Section 6 – Why We Need Our Students to be Design Thinkers* offers a step by step process to guide participants (students, colleagues, community members) through a design thinking process. For more information and resources about design thinking and facilitation, please see the first toolkit, *Toolkit for Challenging Contexts: Taking Making into Schools* (https://issuu.com/ubcedo/docs/toolkit4cc_english and https://issuu.com/ubcedo/docs/toolkit4cc_kiswahili)

Intentionally positioning design and making in schools supports Javis' view (2007) that "Learning is essential - indeed, like food and water are essential to the growth and development of the body, learning is an essential ingredient to the growth and development of the human person; it is one of the driving forces of human becoming and enriches human living." To design is to learn and to proactively personalize learning through an intentional process!

Design thinking is an essential tool for teachers and students to personalize their learning and make change in their actions, worldview, and sense of selves. It is an essential component in the development of emotion intelligence and resilience.

5.2 Tinker

We define tinkering as the actual hands-on making of things based on a design. Tinkering produces a tangible but not necessarily final prototype, model or metaphor of a solution to a design challenge. It can also provides the student time to use and explore the teacher-made resources.

Tinker is the second phase of the *Taking Making into Classrooms* cycle. It is through tinkering that students begin to make their thinking visible (Eisner, 1998). Tinkering is a way of engaging with resource that moves the engagement beyond simple play with the object and toward purposeful play with concepts and big ideas that the resource supports. Typically,

Making and Modifying: A Part of Tinkering and Thinkering

Types of Powerful Questions

Powerful questions support open discussion and sustain dialogue. Some suggestions of each type of powerful questions are provided below.

OPENING QUESTIONS
- What is your intention?
- What impact might this have?
- What are some other possibilities?
- What other ideas do you have about it?

PROBING QUESTIONS
- Can you give me an / another example?
- What have you tried so far?
- How did that work?
- What might be missing?

ACTION QUESTIONS
- What are your next steps?
- What are you willing to do to refine this?
- What strengths do you see with this?
- What would be helpful in assisting you?

CLARIFYING QUESTIONS
- What are your next steps?
- What are you willing to do to refine this?
- What strengths do you see with this?
- What would be helpful in assisting you?

OPTIONS
- What are your next steps?
- What are you willing to do to refine this?
- What strengths do you see with this?
- What would be helpful in assisting you?

BLOCKS
- What got in the way?
- What if this doesn't work, initially?
- What's your backup plan?
- Are you prepared to take this further?

we encourage students to work in groups of four but classroom grouping is an organization issue that teachers will have to address – depending on how many resources are available, etc. As students work together with the resource, they begin to think aloud about concepts and surface different ideas. When students engage in thinking aloud within a group, their classmates can engage with them as critical friends and offer timely supports, ideas, and modifications. Thinking aloud forms a link between tinkering and thinkering in the design thinking cycle as it bridges initial ideas with increasingly complicated ideas and questions. It is through tinkering that curiosity is fostered.

5.3 Thinker

We define *thinkering* as thinking about what you have been tinkering.

Thinker is the third phase, and it helps groups to share learning and embrace the potential richness of divergent, ambidextrous thinking that multiple points of view can provide. Realizing that everyone started with the same resource, thinkering brings a forced stop to the tinkering and invites each group to summarize its activities – process, ideas and questions. It requires all participants to become critical friends and to learn to ask good, fair minded, open questions. Students need time to learn to be critical friends. The development of critical friends is part of a developing a safe, risk-taking environment in which innovation and creatively is encouraged. We value the use of the revised Bloom's taxonomy questions as a way to introduce students into the types of questions that open conversations and encourage iteration. A table, *Revised Bloom's Taxonomy* in Section 6: *Why We Need Our Students to be Design Thinkers,* includes process verbs, assesments, and question stems.

Learning to ask good questions is an essential outcome of Design Thinking. Asking good and powerful questions is also an important way for teachers to engage with students as the students are using resources to support learning. People working in the fields of coaching and leadership (Whitworth,

Taking Time to Think and Discuss is Always Time Well Spent

Kimsey-House & Sandahl, 1998; Payne & Hagge, 2009) suggest that powerful questions support open discussion and sustained dialogue.

As students work with a resource to make meaning, the teacher might ask the students the following series of questions:

1. What do you think?
2. Why do you think that?
3. How do you know that?
4. Can you tell me more?
5. What questions do you have now?
6. What else do you want to know now?

These questions can be used for informal and formative assessment. The student responses will give the teacher a good insight into what the student knows, needs to know, and wants to explore further.

5.4 Reflect

We define reflect as the personal pause to consider one's work in light of other solutions and ideas. It is a necessary stop in the action before moving on to either a re-design or the next design challenge. It should play a significant role in the assessment process.

The reflect phase can be seen as the final phase of the design cycle or the start of iteration and re-design. It is a natural extension of the thinkering process. We encourage both group reflection as well as individual reflection as part of the informal assessment process. Reflection helps students to make their thinking visible (Eisner, 1998) and consider what they have learned and what they need to learn next. It can be used as part of formative assessment. It helps students to document their own learning, recognizing they can often be so busy in the process they forget what they actually learned. Reflection also helps with closure to using a resource, and it can be used to inform the next steps in personalized learning. However, one of the most important things reflection can do is to provide thinking time; time to consider what was done and why; what were the contributions, what could be better next time, etc. Reflection is essential for iteration because it helps informed what could be done next. In terms of the design process, reflection helps students see what they designed and then make decisions as to how that design could be better.

5.5 Fostering Habits of Mind

By honouring all the four phases shared previously in this section, students begin to gain competency, confidence, and learn to engage in purposeful play and appreciate hard fun. In teacher directed learning, teachers often ask too little of their students and require only their passive attention to the teaching. Through this purposeful play, students begin to develop the Habits of Mind that will serve them well in their future including more difficult learning and life challenges.

Habits of Mind have been identified as a set of 16 problem solving, life related skills, necessary to effectively operate in society and promote strategic reasoning, insightfulness, perseverance, creativity and craftsmanship (Costa & Kalliak, 2000). The understanding and application of these 16 Habits of Mind serve to provide students with skills to work through real life situations that will equip them to respond using awareness (cues), thought, and

intentional strategy in order to gain a positive outcome.

1. ***Persisting:*** Sticking to task at hand; Follow through to completion; Can and do remain focused.

2. ***Managing Impulsivity:*** Take time to consider options; Think before speaking or acting; Remain calm when stressed or challenged; Thoughtful and considerate of others; Proceed carefully.

3. List***ening with Understanding and Empathy:*** Pay attention to and do not dismiss another person's thoughts, feeling and ideas; Seek to put myself in the other person's shoes; Tell others when I can relate to what they are expressing; Hold thoughts at a distance in order to respect another person's point of view and feelings.

4. ***Thinking Flexibly:*** Able to change perspective; Consider the input of others; Generate alternatives; Weigh options.

5. ***Thinking about Thinking (Metacognition):*** Being aware of own thoughts, feelings, intentions and actions; Knowing what I do and say affects others; Willing to consider the impact of choices on myself and others.

6. ***Striving for Accuracy:*** Check for errors; Measure at least twice; Nurture a desire for exactness, fidelity & craftsmanship.

7. ***Questioning and Posing Problems:*** Ask myself, "How do I know?"; develop a questioning attitude; Consider what information is needed, choose strategies to get that information; Consider the obstacles needed to resolve.

8. ***Applying Past Knowledge to New Situations:*** Use what is learned; Consider prior knowledge and experience; Apply knowledge beyond the situation in which it was learned.

9. ***Thinking and Communicating with Clarity and Precision:*** Strive to be clear when speaking and writing; Strive be accurate to when speaking and writing; Avoid generalizations, distortions, minimizations and deletions when speaking, and writing.

10. ***Gathering Data through All Senses:*** Stop to observe what I see; Listen to what I hear; Take note of what I smell; Taste what I am eating; Feel what I am touching.

11. ***Creating, Imagining, Innovating:*** Think about how something might be done differently from the "norm"; Propose new ideas; Strive for originality; Consider novel suggestions others might make.

Habits of Mind may be applied in any learning context

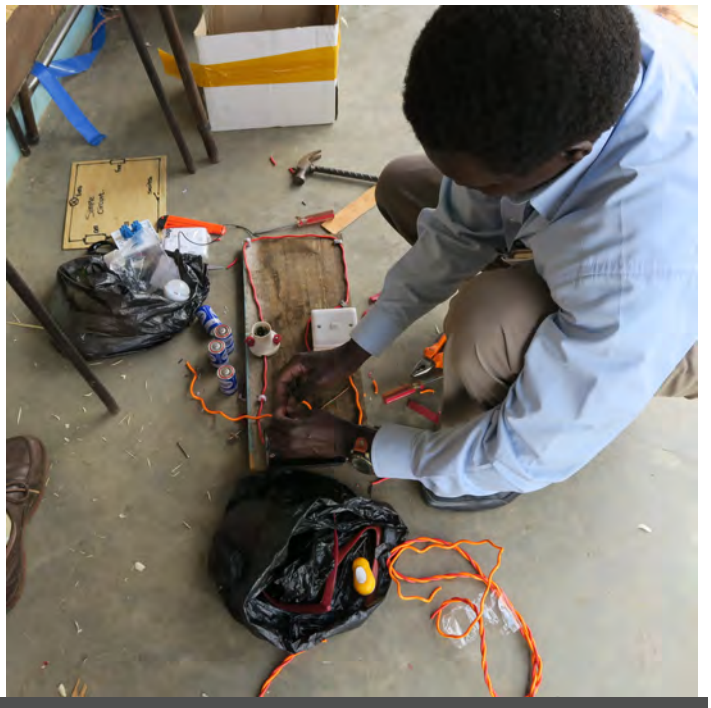
12. ***Responding with Wonderment and Awe:*** Intrigued by the world's beauty, nature's power and vastness for the universe; Have regard for what is awe-inspiring and can touch my heart; Open to the little and big surprises in life I see others and myself.

13. ***Taking Responsible Risks:*** Willing to try something new and different; Consider doing things that are safe and sane even though new to me; Face fear of making mistakes or of coming up short and don't let this stop me.

14. ***Finding Humor:*** Willing to laugh appropriately; Look for the whimsical, absurd, ironic and unexpected in life; Laugh at myself when I can.

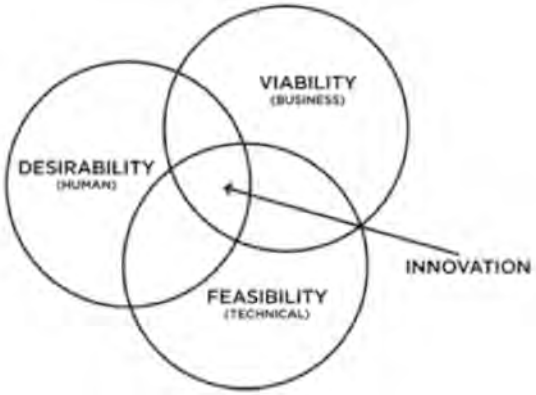
15. ***Thinking Interdependently:*** Willing to work with others and welcome their input and perspective; Abide by decisions the work group makes even if I disagree somewhat; Willing to learn from others in reciprocal situations.

16. ***Remaining Open to Continuous Learning:*** Open to new experiences to learn from; Proud and humble enough to admit when don't know; Welcome new information on all subjects.



Habits of Mind may be considered as part of assessment process in a well-crafted local Making resource

Three Components of Innovation



- Source: Stanford d.School

Design thinking helps to foster innovation by considering three components of a solution: what is wanted (desirability), what is possible using existing materials and technologies (feasibility), and what is affordable (viability).

Design thinkers then move through a five step process, repeating any or all of the steps as needed. These steps are: Empathy, Define, Ideate, Prototype and Test.

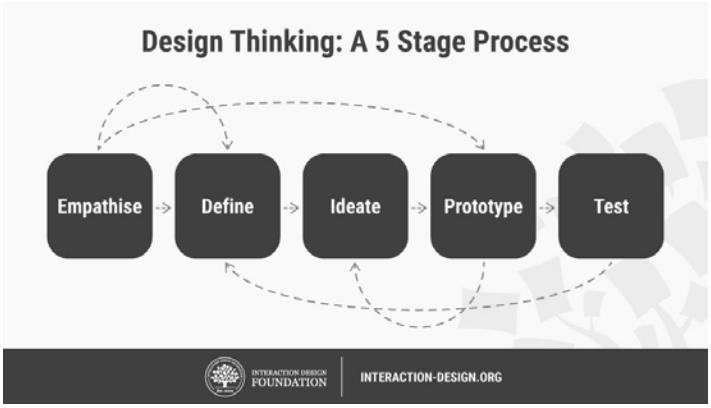
Section 6: Why We Need Our Students to be Design Thinkers

The world of work is changing. Globalization, creation of new jobs, climate change, different ways of working amongst other factors have impacted us all. Where once there was a vibrant economy in the creation of small good and products - j*ua kali*, cheaper imported goods have replaced those products and often the need for the workers themselves. Machines and automation have taken many lower skilled jobs. These changes cause people to ask, *how do we prepare ourselves and our children for an uncertain future? What will the world of work look like for youth in challenging contexts, both rural and urban?*

Teachers across every education system ask, *How will we ensure we are educating our students to become full, proactive members of a global society with a dynamic future in which change will be a constant*? We know the ability to think well is essential and the ability to use a design thinking approach and make tangible representations of learning is important.

Design thinking is a human centred design process that seeks to gain understanding of the concerns, insights, lived experiences, and / or needs of others before beginning to develop solutions. Design thinking allows us to think beyond what currently exists. It allows us to begin to imagine what might be! It is a process typically used to wrestle with real world challenges and make meaningful changes. It starts with a consideration of how real people, in real situations, will use and be impacted by the solutions we are proposing. We call this design process – human centred design.

Five Steps of a Design Thinking Process



6.1 Traits of A Design Thinker

As students engage in a human-centered design thinking process, they learn how to approach real world challenges, difficult concepts, and many perspectives by fostering the traits of a design thinker. These traits include:

- **Empathy** – Ability to image the world from multiple perspectives
- **Integrative thinking** – Ability to exploit opposing ideas and opposing constraints to create new solutions
- **Optimism** – Ability to assume no matter how challenging the constraints of a given problem, at least one potential solution is better than the existing alternatives
- **Experimentalism** – Ability to pose questions and explore constraints in creative ways that proceed in entirely new directions
- **Collaboration** – Ability to work together and require that complex problems require enthusiastic interdisciplinary collaboration (Tim Brown, 2008)

The initial step in a human-centered design thinking process is gaining empathy through guided conversations with others. At the heart of well-crafted, guided conversations are well-crafted questions that are open-ended, engaging and politely probing.

6.2 Crafting Open Ended Questions – Using Bloom's Taxonomy Question Stems

Learning to ask good questions is one of the many important outcomes of the Design Thinking process and part of what Papert called *hard fun* for students (See Section 3.1). By introducing students to the *Revised Bloom's Taxonomy Chart* below, teachers are provided examples of process verbs, types of assessment and question stems for asking increasingly complex, higher order questions. We value the use of the revised Bloom's Taxonomy questions as a way to introduce students into the types of questions that open conversations, engage collaboration, and encourage iteration (https://www.cloud.edu/Assets/PDFs/assessment/revised-blooms-chart.pdf).

Revised Bloom's Taxonomy				
LEVEL OF TAXONOMY / DEFINITION	**PROCESS VERBS**		**ASSESSMENTS**	**QUESTION STEMS**
Creating: **Complex Thinking and Questioning** Generating new ideas, products, or ways of viewing things Examples: Constructing, Designing, Inventing, Planning, Producing	Act Arrange Assemble Combine Compose Construct Create Design Develop Devise Formulate	Generate Improve Infer Invent Imagine Plan Predict Prepare Revise Show Write	Advertisement Blueprint Cartoon Collage Formula Invention New game Newspaper Painting Plan Play Poem Song Story Video	Can you create new and unusual uses for …? Can you design a … to … ? Can you see a possible solution to …. ? How many ways can you …? How would you devise your own way to…? What would happen if…?
Evaluating: Justifying a decision or course of action Examples: Checking, Critiquing, Experimenting, Hypothesizing, Judging	Argue Assess Choose Compare Conclude Criticize Debate Decide Defend	Determine Evaluate Justify Prioritize Rate Recommend Support Tell why Value	Conclusion Debate Editorial Investigation Judgment Opinion Recommendation Report Survey Verdict	Do you think…is a good or bad thing? How effective are…? How would you feel if…? Is there a better solution to…? What are the pros and cons of …? What do you think about…?

Revised Bloom's Taxonomy				
LEVEL OF TAXONOMY / DEFINITION	**PROCESS VERBS**		**ASSESSMENTS**	**QUESTION STEMS**
Analyzing: Breaking information into parts to explore understandings and relationships Examples: Comparing, Deconstructing, Finding , Interrogating, Organizing	Calculate Categorize Classify Compare Contrast Diagram Differentiate Discover Distinguish Examine Experiment	Group Interpret Investigate Order Organize Question Relate Research Sequence Solve Survey	Chart Checklist Database Diagram Graph Illustration Investigation List Outline Plan Questionnaire Report Spreadsheet Summary	Do you think…is a good or bad thing? How effective are…? How would you feel if…? Is there a better solution to…? What are the pros and cons of …? What do you think about…?
Applying: Using information in another familiar situation Examples: Carrying Out, Executing, Implementing, Using	Adapt Apply Calculate Change Compute Demonstrate Dramatize Draw Experiment Illustrate	List Make Manipulate Practice Produce Sequence Show Solve Teach Use	Demonstration Diagram Experiment Illustration Journal Map Model Prepare Lesson	Do you know of another instance where…? Can you group…? Which factors would you change…? What questions would you ask of…? From the information given, can you develop a set of instructions about…?

Revised Bloom's Taxonomy				
LEVEL OF TAXONOMY / DEFINITION	**PROCESS VERBS**		**ASSESSMENTS**	**QUESTION STEMS**
Understanding: Explaining ideas or concepts Examples: Classifying, Explaining, Interpreting, Paraphrasing, Summarizing	Ask Calculate Convert Describe Discuss Explain Give Examples Identify Locate	Observe Recognize Report Research Retell Review Summarize Tell	Debate Definition Dramatization Example Explanation Label List Outline Quiz Recitation Reproduction Story Set Problems Summary Test	Can you write in your own words … ? How would you explain…? What might happen next? What was the main idea…? Who do you think…?
Remembering: Recalling information Examples: Describing, Finding, Listing, Naming, Recognizing, Retrieving	Choose Cite Define Describe Give Example Group Know Label List Listen Locate	Match Memorize Name Quote Recall Recite Record Repeat Select Underline	Definition Facts Label List Quiz Reproduction Test Workbook Worksheet	Can you name…? How many…? What happened after…? What is…? Which is true or false? Who …?

6.3 Experiencing a Human-Centered Design Thinking Process

Note: Section 1, *Academic Underpinnings,* in the *Toolkit for Challenging Contexts: Taking Making into Schools (https://issuu.com/ubcedo/docs/toolkit4cc_english)* provides additional background regarding Making, Active Learning, and Design Thinking.

A design thinking process starts with a real world challenge. Rather than hurrying to find a quick solution or trying to immediately replicate generalized solutions, a design thinking process is used to find and identify the source of the challenge by the people experiencing it and the factors that may influence its successful implementation within a given context.

Participants engage in a design thinking process starting with a facilitated, guided conversation with colleagues, partners and possibly community members. By asking guided, open ended questions, these conversations support problem finding and problem identification before problem solving.

The following Design Challenge and Design Thinking process will help you to lead a human-centered design thinking process using the content within this Toolkit. It assumes you will be using this process with educations to discuss the design and development of well-crafted local Making resources.

Design Challenge:

How do local well-crafted Making resources support active learning and foster a growth and an intentional mindset? Further, how do teachers in challenging contexts locate, develop and use these types of resources in their teaching, especially in large class settings?

Before Starting the Design Thinking Process:

1. Make sure all participants have a partner. Partners might be individuals who teach the same subject or the same grade level.

2. Introduce participants to the design challenge. Introduce participants to the design thinking process. Explain this series of activities will be timed. Assure the participants there may be activities that seem way too long or way too short. Ask everyone to save their questions about the process until after it is completed. For now, trust the process.

3. Give each participant a piece of A4 paper, a sharpened pencil, and an eraser. Ask them to fold the paper into 4 parts and number the parts 1-4. Have extra sheets of paper, pencils, and if possible, a pencil sharpener available to the participants.

1.	2.
3.	4.

4. Ask each pair to identify who will be Participant A and who will be Participant B. Before starting, ask Participant As to raise their hands. Thank them. Then ask Participant Bs to raise their hands. Thank them. This gives you a quick way to ensure everyone heard your instructions, has made a choice, and are ready to start.

Design Thinking Process:

1. Instructions for Part #1: Empathy

Learning about your partner's perspectives and knowledge

Guiding Questions: *What is the role of well-crafted resources in supporting active learning? How do resources help students develop a growth and intentional mindset?*

- Participant A will have 3 minutes to listen as Participant B responds to the general questions. Participant A will record Participants B's responses in Part #1 on their own sheets. Remind Participants they may need to ask additional powerful, open ended questions as prompts. There are many examples of powerful questions in the toolkit.

- Start timing. Once the time is over, remind Participant As to add any additional notes in Part #1 on their sheets.

- Switch roles: Participant B will have 3 minutes to listen to and question Participant A, using the same general questions and any additional powerful, open-ended questions as prompts. Remind Participant Bs to record the responses in Part #1 on their sheets.

- Start timing. Once the time is over, remind Participant Bs to add any additional notes in Part #1 on their sheets.

2. Instructions Part #2: Define Challenges

Learning about your partner's experiences and contexts

Guiding Question: *What are the challenges teachers face in using active learning resources in their classrooms?*

- Participant A will have 3 minutes to listen and prompt with powerful, open-ended questions as Participant B responds to the question. Participant A records Participant B's responses in Part #2 on their sheets.

- Start timing. Once the time is over, remind Participant As to write additional notes in Part #2 on their sheets.

- Switch roles: Participant B will have 3 minutes to listen and prompt with powerful, open-ended questions as Participant A responds to the question. Participant B records Participant A's responses in Part #2 on their sheets.

- Start timing. Once the time is over, remind Participant Bs to write additional notes in Part #2 on their sheets.

3. Instructions for Part #3: Define Evidence

Guiding Question: *How are your past experiences and learning informed the challenges you have described?*

Additional Guiding Question: *How do you know this?*

- Participant A will have 2 minutes to listen and prompt as Participant B responds to the questions.

- Start timing. Once the time is over, remind Participant As to write additional notes in Part #3 on their sheets.

- Switch roles : Participant B will have 2 minutes to listen and prompt as Participant A responds to the questions. Participant B records Participant A's responses in Part #3 on their sheets.

- Start timing. Once the time is over, remind Participant Bs to write some notes in Part #3 on their sheets.

4. Instructions for Part #4: Ideate

Asking your partner to form creative solutions to address their unique challenges

Guiding Question: *How might you or your institution address those challenges?*

- Participant A will have 3 minutes to listen and prompt as Participant B responds to the question.

- Start timing. Once the time is over, remind Participant As to write additional notes In Part #4 on their sheets.

- Switch roles: Participant B to listen and prompt as Participant A responds to the question. Participant B records Participant A's responses in Part #3 on their sheets..

- Start timing. Once the time is over, remind Participant Bs to write additional notes in Part #4 on their sheets.

5. Instructions for Part #5: Prototype

Asking participants to work individually to create a prototype of a possible solution

Ask Participants to turn their papers over. Ask the Participants to divide their paper into half numbering one half #5 and the second half #6

5.	6.

Guiding Question: *After reviewing all your notes and reflecting on all the information you and your partner have created, what resource would you begin to develop to support active learning, foster a growth and intentional mindset for your students? How would your resource address at least one of the challenges you and your partner discussed?*

- Before starting the timing, review the Design Challenge question. Remind participants the definition of a prototype as a representation of one or more ideas to show how you might begin to solve the design challenge.

- Participants will be given 5 minutes to answer the guiding questions individually. Ask Participants to describe, using words and / or drawings, how they would begin to develop and design a quality resource that could support active learning and foster a growth and intentional mindset in your students.

- Start timing.

6. Instructions for Part #6: Test

Asking another participant to be your critical friend as you describe your resource

Participants will share their ideas with a Participant in the room that was not their Partner for Parts 1-4. Remind the Participants to write down any additional ideas or questions their critical friend surfaces. Ensure that both Participants have time to present and receive feedback. Remind everyone to have some notes in Part #6 on their sheets.

Before starting, remind Participants what it means to be a Critical Friend.

- Ask open questions (*Types of Powerful Questions* or *Revised Bloom's Taxonomy Table* provides examples)
- Give constructive feedback
- Offer supportive ideas
- Use "and" rather than "but" when offering feedback

If time allows, have the original partners met to go over their solutions and feedback.

NOTE: Teachers could use this same Design Thinking process with their students. Obviously, the question prompts would change, and this process could help students to discuss their questions concerning curriculum topics or as a way to introduce a new curricular topic.

The following are two examples teachers could use in their own classrooms. Note: these examples may require some easy modifications for your context.

Design Challenge #1 – Pythagoras Theorem: How could you use Pythagoras's Theorem to help you in the real world of work?	**Design Challenge #2 – Writing a Really Short, Short Story:** Using the *Sample Resource 9.8 Simple Folded Books*, ask the students to develop a short story that could be told and illustrated in only 6 pages. Tell the students their stories can only have 2 characters, 1 dramatic piece of action, and the conclusion needs to be a lesson learned from the action. Completed books are 8 pages in length: A Title Page + 6 story pages + A Final Drawing.
Question 1 Do you fully understand Pythagoras Theorem? What questions do you have? How do you think it could be use in a real life application?	**Question 1** What is an action or activity that other children could learn a lesson from? For example, how do we learn that fire can burn you or bees can sting you or???
Question 2 What challenges might you have in using Pythagoras Theorem in the example you gave in #1?	**Question 2** Who are 2 characters that could participate in that action or activity?
Question 3 How do you know the answer you gave in #1 and #2 are correct? What evidence or experience do you have?	**Question 3** How do you know the action or activity could take place with your characters? What evidence or experience do you have?
Question 4 How could your teacher or classmates or family help you to use Pythagoras's Theorem in a real world example?	**Question 4** What is the setting for the characters and the action / activity?
Question 5 Sketch or write out the actual way in which you would use Pythagoras Theorem in the example you have given. Provide details of the tools or materials you might need to use Pythagoras's Theorem.	**Question 5** Storyboard the 6 pages of your story. What happens on each page? Does the action or activity happen by page 3 or 4? Is the last page of the story where we learn the lesson
Question 6 What feedback did your critical friend offer you concerning your example and the example you shared in #5?	**Question 6** What feedback did your critical friend offer you concerning your storyboard? Are you ready to start writing and illustrating your story on the paper provided

Two Examples for Design Challenge #1 – Using Pythagoras Theorem in the Real World

1. Two friends are meeting at the school. Friend 1 is already at the school, but Friend 2 needs to get there taking the shortest path possible. Friend 2 has two ways to go - follow the roads to the school - first heading south 3 km, then heading west 4 km. The total distance covered following the roads will be 7 km. The other way Friend 2 can get there is by cutting through some open fields and walk directly to the school. If we apply Pythagoras's theorem to calculate the distance you will get:

$(3)^2 + (4)^2 =$
$9 + 16 = C^2$
$\sqrt{25} = C$

5 KM = C

Cutting through some open fields and walking directly to the school will be 2 KM shorter than walking along the roads.

2. Painters use ladders to paint on high buildings and often use the help of Pythagoras Theorem to complete their work. The painter needs to determine how tall a ladder needs to be in order to safely place the base away from the wall so it won't tip over. In this case the ladder itself will be the hypotenuse. Take for example a painter who has to paint a wall which is about 5 m high. The painter has to put the base of the ladder 2 m away from the wall to ensure it won't tip. What will be the exact length of the ladder required by the painter to complete his work? You can calculate it using Pythagoras Theorem:

$(5)^2 + (2)^2 =$
$25 + 4 = C^2$
$\sqrt{29} = C$

5.3 m. = C

Thus, the painter will need a ladder with an exact length of 5.3 meters.

Notes

Making provides opportunities for teachers and students to learn to safely use simple hand tools.

Making allows students to use simple hand tools and to learn how to safely collaborate with other students.

For teachers, creating these safe makerspaces may require some organizing to ensure students may move around freely. Many these makerspaces will be based on available space and tools. The overall intent of these makerspaces is to engage students in meaningful acts of creation linked to curricular activities.

Section 10 provides some suggestions for simple tools and consumables to start a makerspace.

Section 7: Safety Issues

When we give students resources to work with and additional materials and tools to explore safety is a concern. Safety is also a concern for teachers as they work with new materials and tools as they build their resources.

7.1 Linking Safety, Intent to Tools and Spaces

When we take Making into classrooms, we want to introduce teachers and students to simple hand tools that allow them cut safely, measure accurately and connect items using glue, wire and fasteners. We may also introduce drills, hammers and hand saws. If we are building Science resources, we might also include small stoves, simple electrical circuits, and soldering.

The emphasis on learning is

- How to measure accurately;
- How to cut safely; and
- How to assemble with care and precision.

Skills for these tasks include instruction into how to

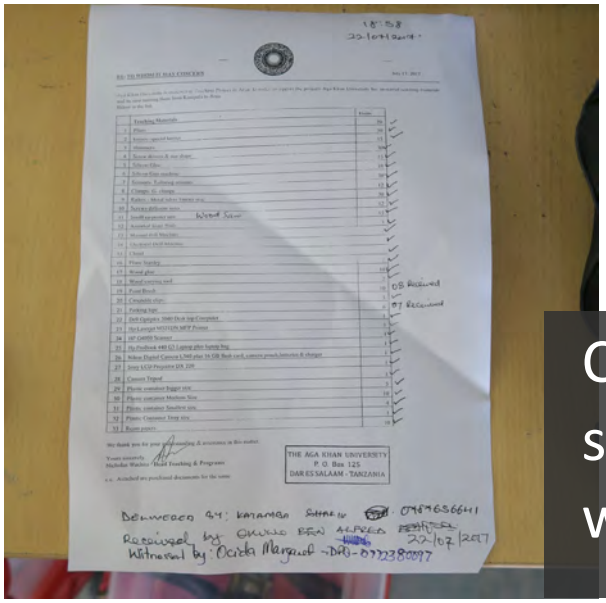
- Use of ruler both for measuring and as a straight edge to cut against;
- Safe ways to walk holding sharp objects;
- Safe ways to use hot elements;
- Ways to help your group members – where to stand, how to hold things, use of tools with and among other people;
- Use of eye and ear protection for user and those immediately around them; and
- Use of gloves – where appropriate.

7.2 Safety Resources

You may wish to create a Safety Station where teachers and students can be shown the proper way to use the tools and materials available. Consider drawing on the expertise of

knowledgeable colleagues, parents, community to help you to hone your skills and possibly to help with the set up and introduction of your Safety Station.

We could also consider having instructions on the use of various resources, maybe even have rules that govern the use of resources especially by students and for resources of high risk such as knives and saws. We must also consider the need to always have a teacher or an adult around when students are engaged in risky activities. Have a first aid box in the school with basic equipment such as bandages, tape, and antiseptic cleaners.



Collaborative activities and safety issues take many forms while creating resources

7.3 Makerspace Safety

The tools and equipment in a makerspace while being useful in making can pose safety risks to students if not used correctly and safely. This understanding creates safety concerns for stakeholders including teachers, school administration and even parents. One way of alleviating this concern is by establishing a safety culture and safety precautions in the makerspace. As a makerspace teacher the following could be important in establishing a safety culture:

1. Understanding the risks and precautions that face the students

As a teacher it is important that you are aware of all the machines and equipment in the maker space and how the way they are stored provides safety for users. Example, are all tools that can potentially cause injury locked up e.g. the power drill. This is so that as a teacher you are able to control their use and who uses them. As a teacher you must also be well aware of the risks this may have on students as they use them and how these risks could be avoided. For example:

Tool	Risk	Precaution
Cutter [knife]	Students could cut themselves This happens when • Cutting • When moving in from one place to the next • If left unlocked	All cutters are kept in a locked cabinet Students use a ruler when cutting to avoid close contact with the sharp edge of the cutter Have a safety rule that all cutters when not in use must be in locked position

2. Establish community responsibility for safety

This begins with first empowering the community by developing training to all those using makerspace for learning about how to safely use the tools and equipment. This should include clear expectations of when and how to use the tools and equipment. In doing this the teacher needs to ask themselves: who has access to which tools? Who knows how to use which tools? Can everyone use all the tools in the makerspace? You will need to decide who has access to what materials and also who to train in the use of certain materials. For example, you do not want a class one student using a power drill. Teaching learners to respect the tools in a makerspace is critical first step towards a culture of safety.

Come up with a training programme for all those using makerspace during which you discuss the use of the tools, the dangers the tools could cause, how to use them safely and what to do in case of an accident. It is also important to establish a clear protocol of what to do when an accident happens:

- Immediate first aid options: have a first aid box at hand
- Who to report to when an accident happens: make sure there is a teacher or an adult in the makerspace when children are working there and make them responsible for the initial first aid in the case of an accident
- Have designated teachers or senior students who get trained in first aid

Be sure to emphasize safety to the users of your Makerspace. Learning how to use a tool is not all that helpful unless you also learn all the risks and precautions you have to take in order to come out of your project build with all your eyes, ears, fingers, and limbs intact.

3. Use clear visuals reminding students of safety issues

It helps to have posters or notices around the makerspace reminding students of the safety rules. Such visuals help deliver a clear and important safety message in a clear and concise manner. Where possible make them colored so they can capture the attention of the students.
Specific visuals should especially be placed in areas where tools and equipment that have a high risk potential to remind students of what to do. For example:

- Remember to clump the wood before cutting
- Watch out for electrical cables
- Always unplug the machine after use
- Remember you can only use this if you have undergone training on how to use it
- Always lock your cutter after use

Protect. Double-check. Aim away. Clamp it. Focus. Never play

4. Model a culture of safety

You can accomplish safety by modeling safe behavior in your own actions and in how you set up the space, setting up a strict training regimen, and posting signs and checklists. Children always learn best by observing. If as a teacher you get in the habit of keeping a safety routine as you work. For example: cleaning up after working, wearing safety equipment then it is highly probable that students will adopt your habit. Modelling safety provides you the teacher with moral authority and opportunity to enforce a strict safety policy throughout the workspace.

Make well-stocked first-aid kits visible and easily accessible throughout your space. Post clear and visible warning signs on all tools and equipment and where necessary also provide personal safety equipment such as goggles, earplugs, gloves, etc. if and when they are available.

5. Store tools and equipment safely

The equipment itself needs to be as safe as possible, probably is wooden or plastic box storage. This ensures that only those allowed to access the tools actually do. It also provides you the teacher with a measure of control over who has access to what in the makerspace. Tools should be well maintained and not have safety features removed or defeated. This is especially important when using old tools whose safety parts may have been removed or not working. When acquiring tools always consider spending an extra amount of money on models with advanced safety features.

6. Create a protocol/ manual to guide activities in the makerspace.

It is important that you have on a notice board or a notice on the wall a summary description of what you consider as the major safety procedures that need to be adhered to in the Makerspace. For example:

Report all injuries.

- Do not attempt to remove foreign objects from the eye or body.
- If chemicals get in the eye(s), wash eye(s) for 15 minutes in an open flow of water before proceeding for medical treatment.

Use protective gear. Dress right.

- Do not wear loose-fitting clothing around moving or rotating machinery.
- Remove ties, jewelry, gloves, etc. especially around moving or rotating machinery.
- Tie back or cover long hair to keep it away from moving machinery.
- Wear only shoes that cover the entire foot, no open-toe shoes or sandals.
- Wear suitable gloves when handling hot objects, glass, or sharp-edged items.
- Wear appropriate clothing for the job (i.e., do not wear short sleeve shirts or short pants when welding).

Prepare.

- Safety is your top priority when using the makerspace. If you are not sure what you are doing, ask.
- Know all the locations of all first aid, fire, and safety equipment.
- Never use a tool unless you've been trained to use it safely.
- Never work alone when using power tools. Two persons must be present and be able to see one another.
- Sign in before using any equipment.
- Do not work in the makerspace if tired, or in a hurry.
- Do not fool around, startle, or distract anyone (not even with a conversation) while either one of you is using a tool.
- Think through the entire job before starting. Prepare prints or drawings with all dimensions and specifications prior to using machines.

Use tools right.

- Use tools only as they were designed to be used.
- Never use a broken tool.
- Report any broken tools or machines immediately.
- Do not remove tools from the room.
- Never walk away from a tool that is still on.
- A hard hammer should not be used to strike a hardened tool or any machine part. Use a soft-faced hammer.
- Operate machines only with all required guards and shields in place.

Clean up.

- Clean up every time whenever you leave an area, including sweeping the floor.
- Clean and return all tools to where you got them.
- Shut off and unplug machines when cleaning, repairing, or oiling.
- Never use a rag near moving machinery.
- Use a brush, hook, or a special tool to remove chips, shavings, etc. from the work area. Never use the hands.
- Keep fingers clear of the point of operation of machines by using special tools or devices, such as, push sticks, hooks, pliers, etc.
- Keep the floor around machines clean, dry, and free from trip hazards. Do not allow chips to accumulate.
- Mop up spills immediately and put a chair or cone over them if they are wet enough to cause someone to slip.

STEMx education includes the discipline areas of Science, Technology, Engineering and Mathematics.

This toolkit provides resource examples that support STEM principles.

In Section 9 , the following well-crafted local Making resources are available:
Simple Machines:
9.13 – Water Pulley for Hand Washing
9.14 – Trundle Wheel | Simplified Surveyor's Wheel

Circuits
9.16 Simple Circuits

Basic Electricity
9.15 Generate electricity from Vinegar / Acidic Fruit Juice Battery

Section 8: Making Connections by Considering TechnologIES in the Most Generous Ways

8.1 An Introduction

Technology typically defines any tool that enables a human capability. Historical examples of technologies include axles, wheels, and pulleys.

For many schools in East Africa, the introduction of digital technologies is more challenging due to access to electricity, the Internet and appropriate devices, including smart phones, tablets, and computers.

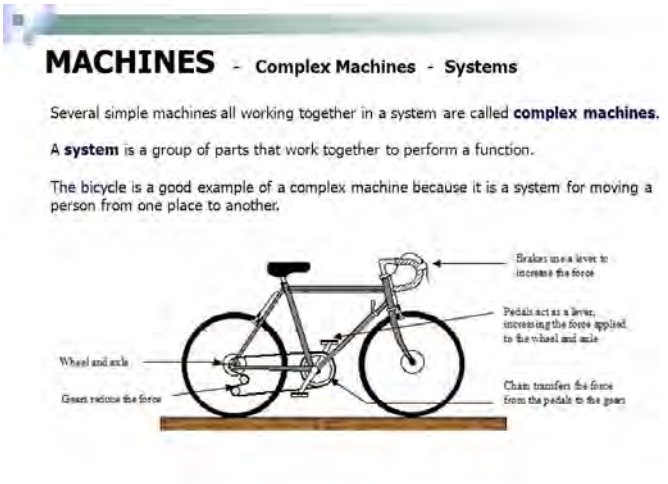
Students can be introduced to digital technologies and coding (the way we read and write software, apps, and interfaces to equipment) through Science and Engineering in the format of coding, simple machines, circuits, and basic electricity. Section 9 provides Sample Resources that illustrate these concepts and many others that may be adapted. Please see Section 9 for Resource examples that illustrate each of these concepts.

Students can learn coding both online and offline by exploring learning activities such as CS Unplugged – an open source resource to support computational thinking (http://csunplugged.org/books/). Included in the Sample Resources in Section 9 is an introduction to Binary Numbers, a key concept in coding. The Binary Activity introduces the way data in computers is stored and shared using a series of zeros and ones. It asks the question, *how can we represent words and numbers using just two symbols – 0 and 1?* See Sample Resource 9.21.

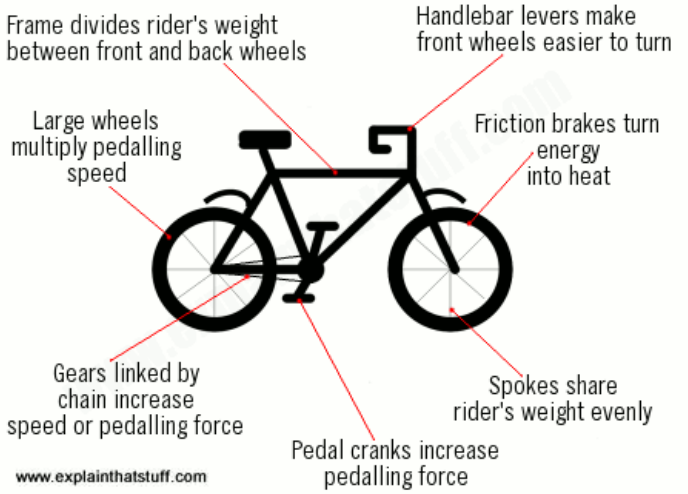
8.2 Using Simple Machines to Make Our Work Easier

Simple machines are classified in six types, and they can be found everywhere - often in some very surprising places and things. Simple machines offer mechanical advantage which makes it easier to do

work. The six simple machines are a lever, inclined plane, wedge, screw, wheel and axle and pulley.



When simple machines are combined into another machine, they are called complex machines. For example, a bicycle is made up of levers (shifters, derailleurs, handlebars, freewheel assembly, brakes); wheels and axles (the wheels, pedals, crank set); pulleys (parts of the shifting mechanisms, braking mechanisms, and the chain on gears); screws that hold parts together; and wedges (the teeth on the gears). When all the simple machines on a compound machine like a bicycle work well together, riders gain a mechanical advantage of traveling faster then they could if they were walking.



Complex machines can be highly technical like airplanes or relatively simple such as a South African designed, hippo roller water carrier (https://www.hipporoller.org/).

The hippo roller has a steel handle, a main body to hold the water that is tapered for easier rolling, a grooved body structure for additional traction when rolling the 90 liters of water, a removable lid to fill the container, and screws to hold the handle in place.

8.3 ISTE Standards for Students – Revised June 2016

The International Society for Technology in Education (ISTE) recently revised their skill and knowledge standards for students (June 2016). The standards include seven skill and knowledge areas. The following table suggestions ways in which a Taking Making into the Classroom approach addresses the new ISTE standards.

ISTE Standards for Students – Revised June 2016		
ISTE Student Standard	**ISTE GENERAL DEFINITION**	**TAKING MAKING PHASE**
Empowered Learner	Student leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.	Design
Digital Citizen	Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.	Design – emphasis on fostering empathy
Knowledge Constructor	Students critically curate a variety of resources using digital tools to construct knowledge, produce artifacts and make meaningful learning experiences for themselves and others.	Tinker Thinker
Innovative Designer	Students use a variety of technologies within a design process to solve problems by creating new, useful or imaginative solutions.	Design Tinker Thinker Reflect
Computational Thinker	Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.	Tinker Thinker
Creative Communicator	Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles formats and digital media appropriate to their goals.	Thinker – emphasis on preparing and for and hosting Gallery Tour Reflection
Global Collaborator	Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.	Design Reflect

Notes

Section 9: Sample Resources

Teachers need to learn to make *well-crafted local Making resources* to support active learning and purposeful play. The introduction of these resources and some of their process is relatively new for students within East African schools and supports the changes in the renewed Tanzanian curriculum. Specifically, these resources support development of core competencies envisaged in the curriculum, which include development of core competencies in reading, writing and arithmetic.

DEVELOPMENT OF CORE COMPETENCES		
READING	**WRITING**	**ARITHMETIC**
Speech (oral language skills)	Basics of writing	Recognition of the concept of numbers
Sound recognition	Letter modeling	Recognition of relationship of quantity of things and numbers
Phonic (sound-letter relationship)	Use of writing principles	Use of actions and operations with numbers
Vocabulary	Accuracy and coherence	Recognition of figures
Reading and listening Comprehension	Writing with chronological order of events	Recognition of measurements
Reading with fluency	Writing with print writing	Assembling and arranging things

Well-crafted Local Making Resources help students beyond discipline related competencies by helping them actively engage in the development of these competencies by helping them learn creativity, actively engage in learning, and provide evidence based demonstrations of their individual learning and learning needs.

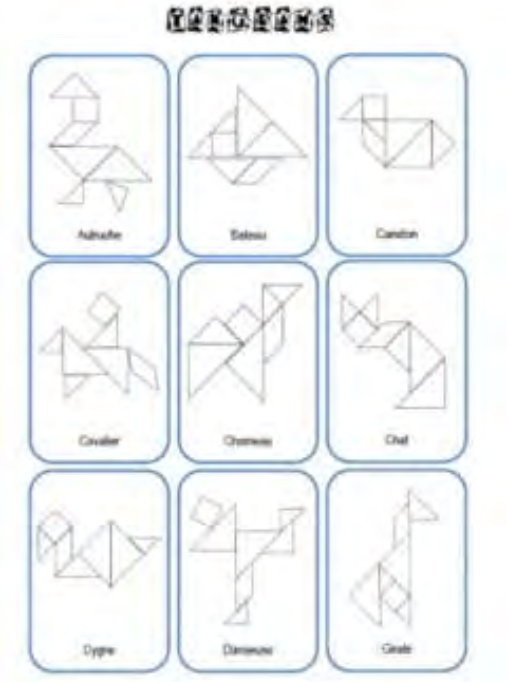
In this Section, examples of well-crafted local Making resources for active learning include

- Math manipulatives that aid in counting and numeracy development. Simple examples of manipulatives include the use of plastic bottle caps for counting (Sample Resource # 5 and #11)
- Puppets to encourage dialogue and to foster language acquisition through storytelling (Sample Resource #19)
- Letter blocks to encourage letter recognition and spelling (Resource #5)
- Tangrams for spatial knowledge and shapes (Resource #1)
- Globes for geography (Resource #3)
- And many, many more ideas

SAMPLE RESOURCES AND DESCRIPTIONS	
RESOURCES	**DESCRIPTION**
1. Tangrams – A Puzzling Task	• Geometric shapes • Spatial Knowledge • Measuring and construction • Art – shapes and aesthetics
2. Yange Yange and Origami – Combining Cultures to Support Active Learning	• Art • Geometry – squares and the shapes that can be found within them • Storytelling using props
3. Globe – Finding Our Place in the World	• Physical location of Tanzania • Place of Tanzania within Africa and the World • Cardinal points and maps • Map reading • Physical features • General geography
4. Solar System – What Other Planets Make Earth's Solar System?	• Science • Measurement • Astronomy • Paper mâché
5. Letter and Number Blocks – Resources with Plastic Bottles	• Identification of letters • Relationship of letters to words • Relationship of words to sentences, etc.
6. Duck – Model of Domestic Animals or Birds	• Environment • Family settings • Science and habitats

SAMPLE RESOURCES AND DESCRIPTIONS	
RESOURCES	**DESCRIPTION**
7. House –Model of Regional Home	• Environment • Families and homes • Shapes and measurement
8. Creating Story Books – Simple Folded Books	• Local stories • Storyboarding • Illustration
9. Creating Picture Books – Using Photographs	• Local stories • Storyboarding • Illustration
10. Building a Solar Oven – Solar Energy and Sustainability	• Science • Mathematics • Design
11. Number Board – Using Magnetic Strips or Hook and Loop Tape	• Identification of numbers • Number – value association • Patterns • Addition and subtraction
12. Sandals for Words and Numbers – Rethinking Uses of Carton and Manila Paper	• Language • Building vocabulary • Word association • Identification of words • Art – matching colours
13. Water Pulley for Hand Washing – Understanding a Single Fixed Pulley	• Simple machines – pulley and its components • Balance and unbalanced forces • Pulling and pushing forces • Science behind simple machines, namely the single fixed pulley • Making work easier • Mathematics, specifically length and weight
14. Trundle Wheel - Simplified Surveyor's Tool	• Simple machines - wheel and axle • Mathematics - measurement and perimeter of a circle • Design- simple second class lever • Technology- friction
15. Building a Vinegar/Acidic Fruit Juice Battery – Generating Electricity	• Science- electrons movement, Magnetism • Mathematics- Different units of measurement • Environment- Renewable and clean energy • Design- simple tools • Technology- circuits, current flow • Safety – hazards and signs

SAMPLE RESOURCES AND DESCRIPTIONS	
RESOURCES	**DESCRIPTION**
16. Simple Circuits – Basic Electronics	• Environment - Reduce, Reuse and Recycle • Mathematics- Measurement • Circuits, Electricity and Electronics • Simple and Compound machines - electric bells
17. Foldscope – A Foldable Microscope for Field Work	• Working with microscopes, specimens, magnification • Scientific Literacy • Using appropriate technologies to aid field work
18. Fun with Flight – Understanding the Four Forces of Flight	• Physics • Engineering • Prototyping and Testing
19. Hand Puppets – Encouraging Storytelling and Fostering Literacy	• Critical thinking • Creative thinking • Storytelling
20. Cardboard Puppets and Stages – Enhancing Storytelling By Adding Sense of Place	• Storytelling • Literacy • Sense of Place
21. Introduction to Binary Numbers – Computational Thinking	• Computational Thinking • Binary Numbers • Representing Digital Information



Sample Resource 9.1 Tangrams
A PUZZLING TASK - HOW 7 SHAPES CAN FORM A SQUARE

RESOURCE DESCRIPTION

Tangram is a Chinese puzzle consisting of 7 pieces or tans. The 7 pieces can be arranged to form a square. They can also be arranged to form other shapes or patterns.

Tangrams are perhaps the oldest and most enduring of all geometric puzzles. There is a story involving the origins of Tangrams. A long time ago in China there lived a man called Tan. Tan's greatest possession was a fine ceramic tile. One day Tan was carrying his tile to show the Emperor. He tripped. The tile fell and broke into 7 geometric shapes: two large triangles, a medium size triangle, a square, and a parallelogram. Tan spent the rest of his life trying to put the tile back together again. He was not successful. He did succeed in creating many different geometric designs.

Tan enjoyed creating the designs. His friends also enjoyed trying to recreate his designs. Tan's puzzles, later called Tangrams, were passed on through generations and from country to country.

COMPETENCE ADDRESSED

- Problem solving – how 7 pieces can become 1 square
- Logical thinking and Perceptual reasoning
- Critical thinking – how to assemble pieces into a square. Extension activity includes, using the 7 pieces to make other recognizable shapes
- Creativity – ability to create other shapes
- Geometric shapes – naming the 7 shapes that make up the Tangram square
- Tessellation – recognizing patterns and the importance of angles
- Spatial literacy – developing skills to see shapes and patterns. It is how we navigate and read our world and is essential for map making

OBJECTIVE(S)

- Introduction to geometric shapes.
- Development of patience and resilience for problem solving
- Development of visual and spatial awareness

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

1. Introduce the basic geometric shapes to students (square, triangle, parallelogram).
2. Give a set of Tangrams to pairs or groups of students.
3. Ask students to form a square with the 7 shapes. Initially, after a time, you might have to provide tips to help the students solve the puzzle.
4. As an extension activity, give students other tangram shapes to try to make. (See *Handout #2: Tangrams Images Variations*)
5. As a further extension ask students to create their own shapes using the 7 pieces. Invite them to challenge their peers with their designs.

22. Allow students to create their own tangram sets using Mathematics rather than simply cutting the shapes using your sets as patterns. The following are the Mathematical directions for creating a tangram set:

   6.1 Make a square of any size
   6.2 Bisect any two sides i.e. length and width
   6.3 Join the bisected points to form an isosceles triangle
   6.4 Place a ruler and make a diagonal line to the isosceles triangle and bisect its longer side
   6.5 Draw the second diagonal on the same square
   6.6 Measure the second diagonal and divide it into four equal parts
   6.7 Join the first quarter to the bisection of the longest side of the isosceles triangle
   6.8 Join the 3rd quarter to the starting point of the bisected isosceles triangle side.

DETAILED STEPS

1. Make a copy of the master TANGRAM square. (See *Handout #1: Tangram*)
2. The square can be enlarged to any size you wish. Just make certain that as you enlarge the square, you retain equal length of each side of the square.
3. Carefully cut the square into its 7 pieces. It is important that each piece be exact with sharp corners and straight lines.
4. Copy each piece to cardboard or wood. This will make a durable set of TANGRAMS that you can reuse in your class.
5. Cut the cardboard or wooden TANGRAMS carefully. Possibly a local funder or craftsman could make wooden sets of TANGRAMS at a reasonable cost.

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe the students as they work with the TANGRAM shapes. Note the way they problem solve and communication.
- Note the collaboration and their capacity for trial and error
- Offer coaching and support as they solve the puzzle

Formative Assessment

- Using a pre-determined checklist of competencies, observe the students growing skills and abilities.
- Share with the students their grades against the checklist criteria and offer suggestions for improvement and growth

Summative Assessment

- After practicing with the TANGRAM puzzles, assess the students' ability to make a set of Tangrams
- After practicing with the TANGRAM puzzles, assess the students' ability to form a square
- After practicing with the TANGRAM puzzles, assess the students' ability to form other practiced patterns

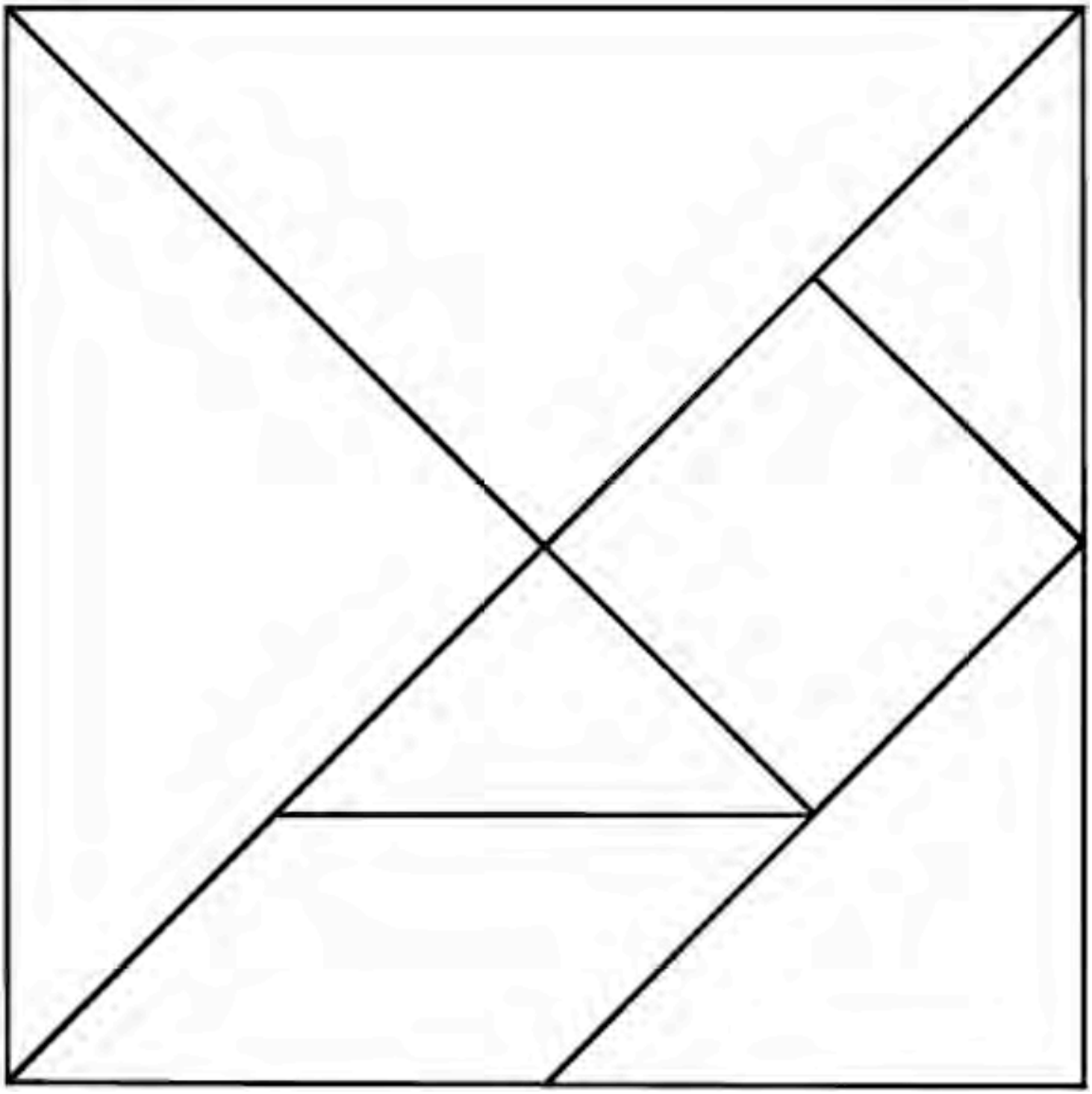
SAFETY TIPS

Tools Needed:

- Ruler or straight edge
- Box cutter or scissors

After you outline the Tangram shape on heavy paper or cardboard, use a straight edge or ruler was a cutting guide. If you are using a box cutter or small knife, remember to cut away from the hand holding the straight edge still. If you are using a box cutter or utility knife, remember to extend the blade of your knife only as far as necessary to cut through the cardboard. Always use some scrap cardboard or wood under the material you are cutting to avoid damaging the tabletop. Remember to cut slowly. Many smaller cuts are easier to manage than attempting to cut through all the layers of cardboard at once!

Sample Resource 9.1 Tangrams
A PUZZLING TASK - HOW 7 SHAPES CAN FORM A SQUARE
HANDOUT #1 TANGRAM FIGURE



Sample Resource 9.2 Yange Yange and Origami
COMBINING CULTURES TO SUPPORT ACTIVE LEARNING

RESOURCE DESCRIPTION

Yange Yange is a famous East African story. It is available in most school libraries as a picture book. The main characters in the story are cranes> The lesson of the story is to be healthy we need to eat and keep ourselves clean. The resource is an Origami crane. Origami is the traditional Japanese art form of folding paper.

COMPETENCE ADDRESSED

- Critical and creative thinking – re-telling the story using Origami cranes as props
- Creativity
- Geometric shapes – observing the shapes that are formed as the paper crane is folded
- Spatial literacy – anticipating the various shapes that make up the crane
- Literacy
- Oral story telling

OBJECTIVE(S)

- Understand the plot of the story and the characters
- Ability to retell a story
- Ability to fold Origami shape with precision and care

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

1. Read the story of Yange Yange to the class. Handout #1: Yange Yange Story
2. Ask the students to identify the main characters – the cranes
3. Help the students to make their own Origami cranes. They can decorate the cranes using crayons or paint or available materials

Invite the students to retell the Yange Yange story using their cranes as props

4. Invite the students to expand on the story – what happens next?

DETAILED STEPS

1. Give the students a sheet of paper (A4, A3 or used chart paper).
2. Teach the student how to make a square by folding a rectangular piece of paper. (See Handout #2: Making a Square)
3. Using the directions in Handout #3: Origami Crane Directions, teach the students how to make their own Origami cranes (http://www.origamiwithrachelkatz.com/folding/crane.php).

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe the students as they listen to the story. Are they following the story and understanding words, ideas and the plot?
- Observe the students as they fold their square from their rectangular piece of paper. Could they fold instructions? Is their square precise?
- Observe the students as work fold their cranes. Are they following directions? Can they follow the sequential steps? Is their work neat and precise?
- Note the way they problem solve and communication.
- Note the collaboration and their capacity for trial and error
- Offer coaching and support as they fold their squares and cranes

Formative Assessment

- Using a pre-determined checklist of competencies, observe the students growing skills and abilities.
- Share with the students their grades against the checklist criteria and offer suggestions for improvement and growth
- Can the students answer questions about the story?

Summative Assessment

- After practicing making their cranes, assess the students' ability to make a crane independently. Can they follow the steps? Can they work carefully and independently?
- After practicing with their cranes, assess the students' ability to retell the Yange Yange story. Do they know the plot, action, and setting? Can they role play and interpret the story for themselves?
- After practicing with the Origami cranes, assess the students' ability to create other shapes.
- Can the student form good questions about the story?

SAFETY TIPS

Tools Needed:

- Scissors
- Paper – can be reused chart paper or photocopy paper or newspaper
- Paint (if you decide to paint the birds)

Make sure children are comfortable using scissors and that they know how to carry scissors carefully around and amongst other children. They should hold the scissors by the blade end rather than the handles when walking around the room.

Sample Resource 9.2 *Yange Yange* and Origami
COMBINING CULTURES TO SUPPORT ACTIVE LEARNING
Handout # 1: The Yange Yonge Story
The story of the Crane (Institute of Education, 2015)

Long ago the Crane and Peacock were close friends.

The Crane had a black breast and the Peacock had a tail with beautiful colors.

The Peacock was a showoff and liked to show his beautiful colours. He liked to tease the Crane that the Crane was only a plain bird.

The Crane did not like what the Peacock said.

One day the Crane met the Butterfly and greeted him saying, "Good morning."

The Butterfly replied, "Good morning."

The Crane told the Butterfly about the jokes his friend the Peacock made.

The Butterfly felt pity for the Crane and promised to help him.
The Butterfly asked the Crane, “What color do you prefer?”
The Butterfly said to the Crane he would help him with one condition. The Crane must cultivate a flower garden for the Butterfly because the Butterfly liked flowers.

The Crane agreed.
The Crane cultivated the garden with great commitment.

When flowers in the garden were ready, the Crane called the Butterfly.
The Crane said, "The garden is ready."

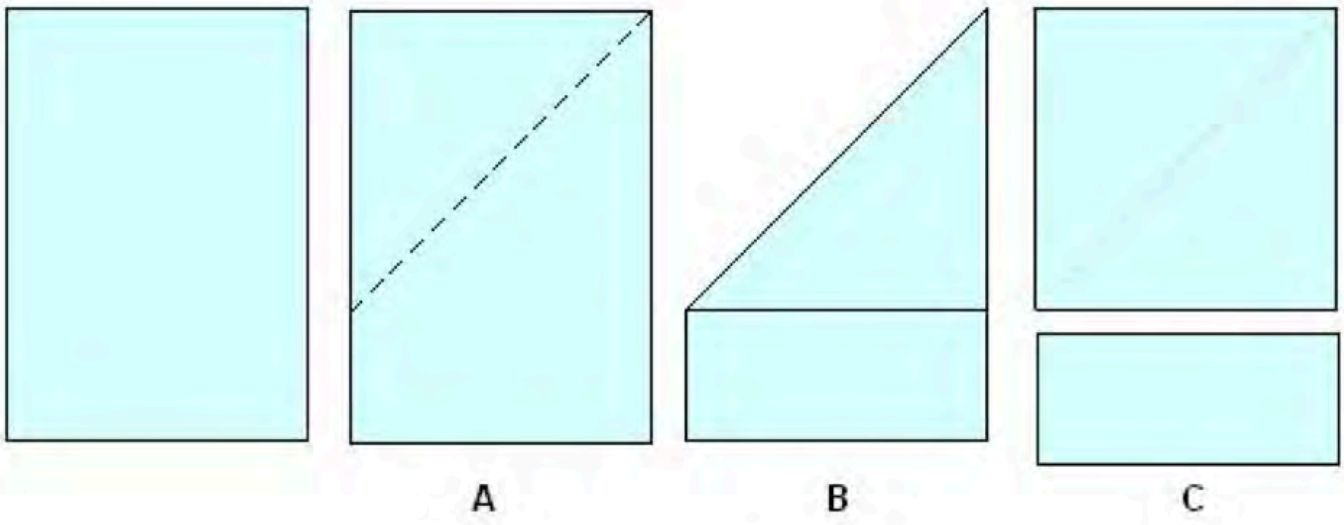
The Butterfly was very pleased with flowers. The Butterfly said, “Eat a flower.”

The Crane ate the flower and immediately turned pure white and looked clean against the blue sky.
He was so happy and jumped up to the sky.

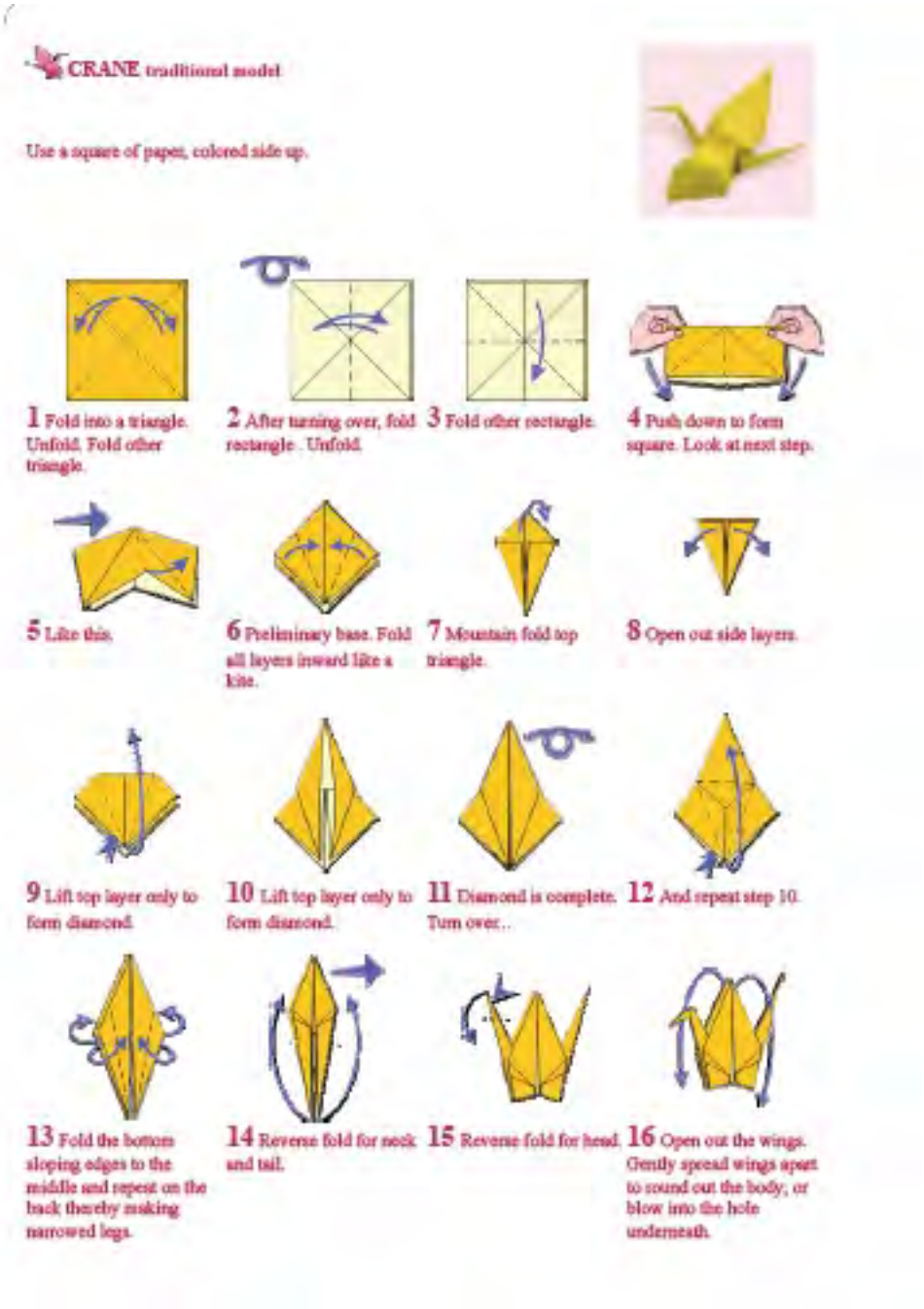
Now when children see a pure white crane, they started singing;
“Peacock gave Crane a flower,
To eat and become clean.
Now, I will remember to bath and wash,
Myself and my food .”

Sample Resource 9.2 *Yange Yange* and Origami
COMBINING CULTURES TO SUPPORT ACTIVE LEARNING
Handout #2: *Making a Square Piece of Paper*

A. Take a sheet of rectangular paper and fold it as shown.
B. Use the edge as a guide to cut off the lower rectangle.
C. Unfold the triangle and you will get a square with a diagonal crease in it. You can save the excess paper for another project.



Sample Resource 9.2 *Yange Yange* and Origami
COMBINING CULTURES TO SUPPORT ACTIVE LEARNING
Handout #3: *Origami Crane Directions*



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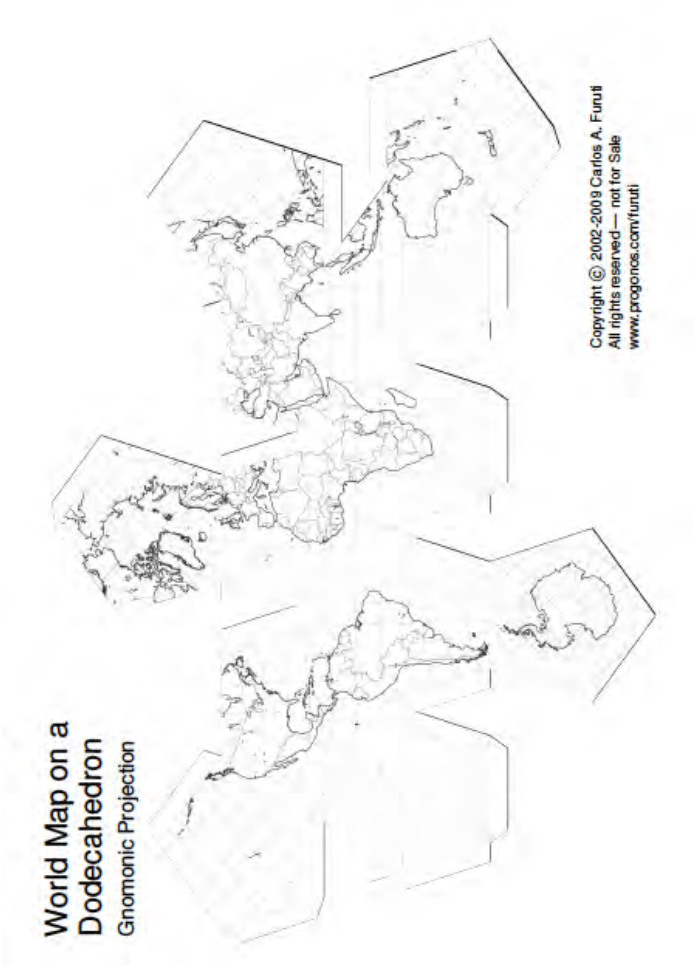


Sample Resource 9.3 *Globe*
FINDING OUR PLACE IN THE WORLD

RESOURCE DESCRIPTION

Globes are three-dimensional models of the Earth. The word globe, in Latin, means round mass or sphere. Globes provide a more accurate depiction of the Earth as flat maps tend to distort the sizes and shapes of the largest areas (continents and oceans). Globes helps students see how the Earth rotates around the sun. It helps them to understand changes in seasons and concepts such as night and day, placement and impact of the Equator and location of the Poles.

COMPETENCE ADDRESSED

- Locate Tanzania within the African continent and the world
- Understand the impact of Tanzania proximity to the equator on its climate and environment
- Understand mapping terms of latitude and longitude
- Locate physical features in the world

OBJECTIVE(S)

- Introduction to basic geography
- Introduction to Tanzania place in the world
- Introduction to difference between 2 dimensional maps and 3 dimensional globes
- Introduction to folding complex shapes
- Introduction to use of colours and scale on maps and globes

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

Teacher can create one globe for the class and use it teach geography and other learning objectives

1. To understand Tanzanian's place in the world
2. To understand the Earth is round
3. To show relationships between northern and southern hemispheres
4. To show trade routes and distances – regionally, nationally, continentally, globally

5. To visualize abstract ideas (boundaries, compass points, latitude, longitude, etc.)
6. To compare flat maps to 3d globes – what is lost and gained in both formats?
7. Talk about different map projections and orientations. Generate questions (e.g. why is north usually at the top of most maps when Tanzania and many other countries are in the southern hemisphere?
8. Show the original location of colonialist and map how they came to East Africa
9. Agents of colonialisms
10. Explain how location impacts our economy
11. Identify areas for tourism
12. Explain how location impacts trade

Students can make their own globes and use them to demonstrate their understandings of the objectives presented above.

DETAILED STEPS

1. Make a copy of the full-page master Globe at the end of this Sample Resource. Also available from http://www.progonos.com/furuti/MapProj/Normal/ProjPoly/Foldout/Dodecahedron/Files/Res3/gnDod-s500_pof-bw.pdf
2. Depending on your intended use, make a copy of the map for each student. Suggested paper size = A3
3. Use a pencil to darken the lines on the copy
4. Use coloured pencils or watercolours to illustrate specific regions, countries, or whatever subject for which you are using the map
5. Cut the map carefully. Make sure you do not cut off the tabs that will be used later to glue the globe together
6. Carefully fold the map, forming the 12-sided globe. If you have heavier paper available, colour the cut-out globe on the heavier paper and cut it out again.
7. Glue the globe partially together and gently begin to stuff it with discarded paper scraps. This will add weight and substance to the finished globe.
8. Finish gluing the globe.
9. Consider inserting a string in flap for the final gluing. You can use the string to hang your globe from the ceiling.

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Ask students to locate places on the globe – start with the African continent then ask the location

of individual African countries.

- Ask students to identify main cardinal points and compass points
- Identify different climate zones and vegetation regions on the map and globe
- Locate significant physical feature (e.g. Zanzibar, Mt Kilimanjaro, Dodoma)
- Identify most likely location of various natural resources

Formative Assessment

- Using a pre-determined checklist of competencies, observe the students growing skills and abilities.
- Share with the students their grades against the checklist criteria and offer suggestions for improvement and growth

Summative Assessment

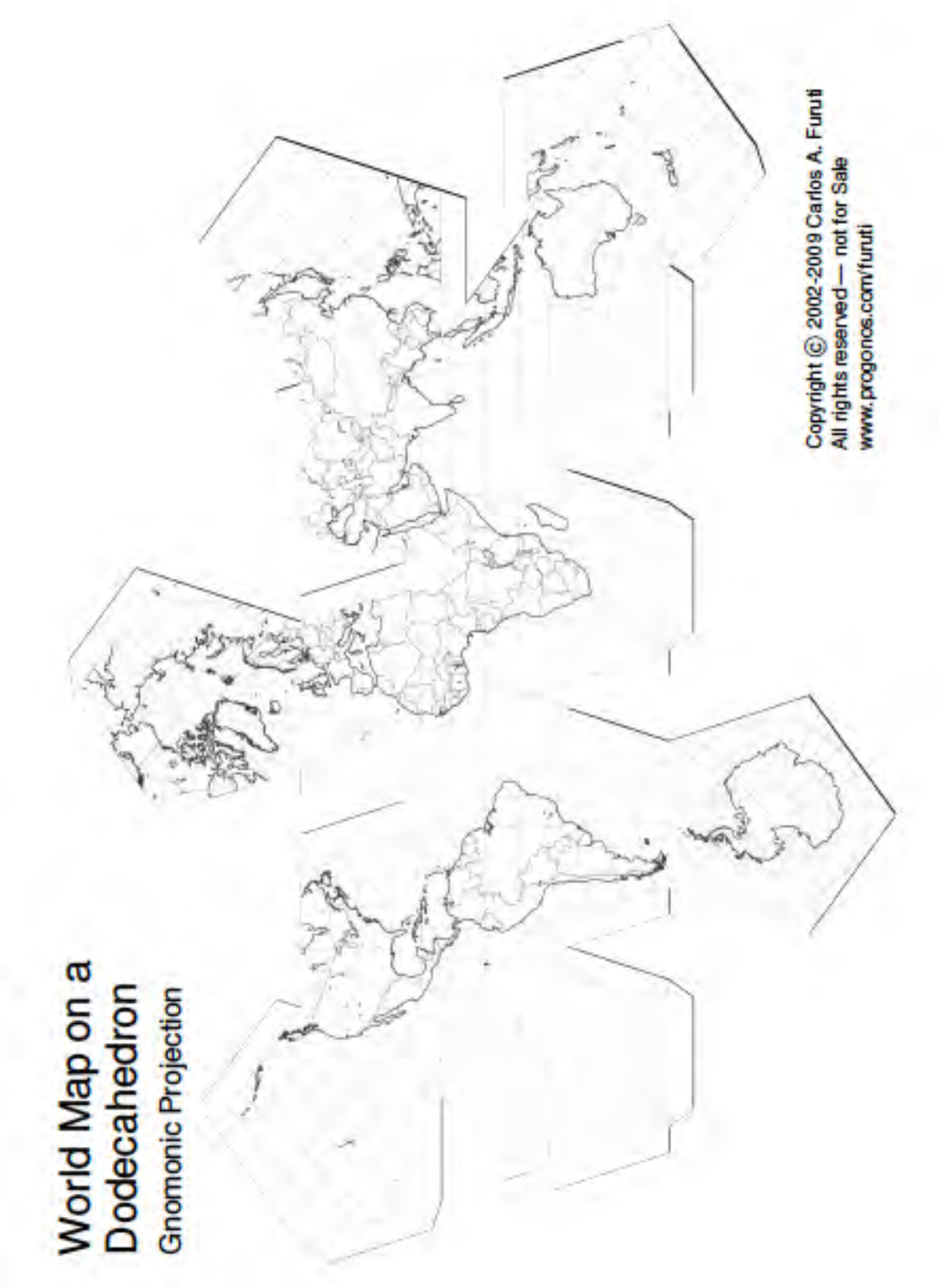
- After practicing with Globe, assess the students' ability to locate and explain specific concepts and ideas that were taught
- After completing their globes, assess the students' ability to work precisely and accurately
- Use the globe to assess significant lesson points and information – form complex questions about how they would design / plan open ended projects such as
    - Where might they location of Eastern Africa Submarine Cable System (EASSy) is an undersea fibre optic cable system connecting countries in Eastern Africa to the rest of the world (http://en.wikipedia.org/wiki/EASSy)
    - How would they suggest improving global trade routes, getting products from land locked African locations to market

SAFETY TIPS

Tools needed:

- Box cutters / Utility Knives
- Scissors

If you are using a box cutter or utility knife, remember to extend the blade of your knife only as far as necessary to cut through the cardboard. Always use some scrap cardboard or wood under the material you are cutting to avoid damaging the tabletop. Remember to cut slowly. Many smaller cuts are easier to manage than attempting to cut through all the layers of cardboard at once! If you are using scissors, remember to cut slowly and to carry the scissors by holding them by the blade.


World Map on a
Dodecahedron
Gnomonic Projection
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www.progonos.com/furuti

Sample Resource 9.4 Solar System
WHAT OTHER PLANETS MAKE UP EARTH'S SOLAR SYSTEM?

RESOURCE DESCRIPTION

A solar system is made up of 9 planets and the Sun. The resource requires 10 paper mâché shapes in various sizes to represent the entire solar system. The largest shape is the Sun. The next shapes, in order, are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

COMPETENCE ADDRESSED

- Planets making of the Solar System
- Size of each planet in relationship to the others
- Distance of each planet from the Sun
- Impact of climate because of distance to the Sun.

OBJECTIVE(S)

- Understanding of the Solar System
- Understanding of planet Earth's location and place within the Solar System
- Understanding of relationship of size / scale / distance

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

1. Introduce the concept of the Solar System to students
2. Introduce the names of the planets
3. Determine a scale for the size of each planet in relationship to one another, consider the following:
4. The Sun is the largest shape you need to make
5. In order of approximate size, the following list ranks the planets from smallest to largest
    - Mercury
    - Mars
    - Venus
    - Earth
    - Uranus
    - Neptune
    - Saturn
    - Jupiter

6. Determine the distance from the Sun for each planet, use the following scale. You may need to make adjustments depending on the size of your classroom.
7. Start in a corner of your room. That is where the completed paper mâché for the SUN can be hung from the ceiling.
    - Mercury = 1 step from sun
    - Venus = 2 steps from sun
    - Earth = 2.5 steps from sun
    - Mars = 4 steps from sun
    - Jupiter = 13 steps from sun
    - Saturn = 24 steps from sun
    - Uranus = 49 steps from sun
    - Neptune = 76 steps from sun
8. Research the colour and approximate shape of each of the planets.
9. Organize your class into groups and assign each group one planet to research and make, using paper mâché

DETAILED STEPS

1. Gather the resources the students will need to understand their group's planet's features.
2. To make paper mâché models of each planet, you need the following materials:
    - Balloons for the four largest planets
    - Newspaper or discarded paper that can be torn into strips
    - Maize flour
    - Large bowl or basin for each group
    - Water
    - Paint
    - String
3. Tear the paper into long strips
4. For the smaller planets, crumple up paper making a small ball that is almost representative of the final size of the planet
5. For the larger planets, inflate the balloons to the appropriate size
6. Place approximately two hands full of flour in the bowl and add water. Mix the flour and water into a smooth, fine paste.
7. Run the strips through the flour / water mix and remove any extra mixture. The paper strips should be wet but not saturated or dripping.
8. Layer the strips onto the balls or balloons (planets) until they are totally covered. It will probably take 2-3 layers to cover each ball.
9. Allow the planets to completely dry.
10. Paint the planets their appropriate colours. Consider adding rings to Saturn. You might want to consider the following colours for each planet.
    - Mercury is typically a slight gray or blue.
    - Venus is a pale yellow.
    - Earth is mainly blue with white for clouds and green and browns land masses.
    - Mars is a reddish brown due to its rusty rocks and minerals.
    - Jupiter is orange with light white bands.
    - Saturn is a pale gold due to its high concentration of ammonia.

- Uranus is a pale blue.
- Neptune is also a light blue due to its high concentration of methane.

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe the students as they work within their groups to make their planet. Note the way they problem solve and communication.
- Note the collaboration and their capacity for trial and error
- Offer coaching and support as they work together

Formative Assessment

- Using a pre-determined checklist of competencies, observe the students growing skills and abilities.
- Share with the students their grades against the checklist criteria and offer suggestions for improvement and growth

Summative Assessment

Test the students on their understanding of the planets – names, distance from the Sun, capability to support live forms, etc.

SAFETY TIPS

Tools Needed:

- Newspaper or discarded paper that can be torn into strips
- Maize flour
- Large bowl or basin for each group
- Water
- Paint
- String

No safety concerns rather than potential for clothes and the work area to become very messy.

Notes

Sample Resource 9.5 Letter and Number Blocks
RESOURCES WITH PLASTIC BOTTLES

RESOURCE DESCRIPTION

Letter blocks (can also be number blocks) are made from recycled plastic water bottles and strips of paper on which a letter or number is written. The use of recycled plastic bottles for challenging contexts has the double benefit of keeping the environment clean and reducing the cost of producing instructional material that is low cost or cost free but fairly durable. It is important that the bottle is transparent (can be seen through) or a light enough hue so that the letters are easily seen. Additionally, any decorations should not interfere with the visibility of what is to be read.

COMPETENCE ADDRESSED

- Sounds and words in Kiswahili
- Sounds and words in English
- Identifying letters of the English alphabet
- Distinguishing capital and small letters
- Using letters of the alphabet to spell and write short words
- Spelling, reading and writing short words and sentences
- Counting

OBJECTIVE(S)

- Identifying letters of the alphabet
- Distinguishing capital and small letters
- Forming, reading and writing syllables and short words
- Identifying different colors
- Reading
- Counting
- Describing things in terms of quality
- Arranging numbers in sequences

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

1. Create enough blocks so children can learn all the letters of the alphabet. Make sure to create

additional blocks for common consonants and all vowels. If you are creating number blocks, remember to create "0."

2. You can use the blocks in a centre and have small groups of children come together and use the blocks. If you have enough blocks, consider giving collections of blocks to each pair of children. Ask them to form sounds, create words, and challenge one another to create additional words.
3. If you are using number blocks, ask the children to create problems, illustrating 2 + 3 = 5 or to show you how many blocks constitute a particular number. For example, have the children show you what the number 12 might look like (e.g. 1 block with 6 on it and another block with 4 and another block with 2).

DETAILED STEPS

1. First collect all the materials needed – one may enlist the help of the learners in collecting empty plastic water bottles
2. Cut bottom parts of the bottles (about 6cm or 2.5 in)
3. Ensure the cutting is smoothly done – avoid sharp jagged edges
4. Cut strips of plain paper or manila paper (about 4cm by 4cm)
5. Write letters of the alphabet or individual numbers on the strips of paper. One letter or number per block.
6. Have multiple letters especially of vowels and popularly used consonants (for making words, multiple letters are needed)
7. Insert the strips of paper in one cut off part of the bottle
8. Cover the piece with another cut off piece making a block with the strip of paper inside

SUGGESTIONS FOR ASSESSMENT

Ask the children to

- Identify letters by picking the specific letter from the pile
- State the name of the letter displayed
- Form simple words by arranging blocks of letters
- Form syllables by arranging blocks of letters
- Form simple sentences, rhymes and poems
- Match capital and respective small letters
- Complete simple crosswords using blocks
- Make words starting with the same letter
- Read letters, syllables, words and sentences displayed on the sets of blocks

- State/ identify the color of the different letters presented
- Copy letters, words from the blocks
- In groups build word banks from the blocks of letters according to guidelines e.g. words starting or ending in a specific letter; words associated with an object(s)

SAFETY TIPS

Tools Need:

- Box Cutter / Utility Knife
- Scissors
- Paper
- Pens

If you are using a box cutter or utility knife, remember to cut away from the hand holding the straight edge still. If you are using a box cutter or utility knife, remember to extend the blade of your knife only as far as necessary to cut through the plastic bottle.

Notes

Sample Resource 9.6 Duck
MODEL OF DOMESTIC ANIMALS OR BIRDS

RESOURCE DESCRIPTION

A model of a duck may be made from old socks, pieces of fabric or sponge, sticks, card box, buttons, paper, glue and thread. The model is painted black/grey and white to make it look like a real duck. Ducks are one of the domestic animals kept in central Tanzania and are easily recognizable by children from this context. They are also non-taboo animals – hence the children can freely touch and talk about the duck. Alternatively, domestic animals or birds may be crafted from papier mâché or other materials. Consider your context as you make other animals or birds.

COMPETENCE ADDRESSED

- Identifying and naming things
- Describing things
- Identifying parts of the body
- Expressing similarity
- Expressing location
- Expressing quality in terms of size

OBJECTIVE(S)

- Understand animals and birds in your community
- Create stories about the animals and birds
- Understand the habitat needed to sustain the animals or birds
- Understand the parts of the animals or birds

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

Use the model of an animal or bird

1. To generate communication about things in the environment
2. To provide a basis for discussion on personal preferences
3. To generate discussion on characteristics of living things and parts of their bodies
4. To prompt learners to identify, name, classify

things in their immediate environment
5. To teach simple numbers
6. To generate discussion on sounds made by different animals
7. To generate discussion on uses of various domestic animals
8. To relate the shape of the animal or bird

DETAILED STEPS FOR THE DUCK

The materials needed to make the model can be sourced from cast offs and recycled materials.

1. First collect all the materials needed
2. Cut up the pieces of cloth and sponge
3. Stuff the cut-up pieces in the sock – shaping it accordingly.
4. Use straps of clothe to shape narrow and wide sections of the body of the duck
5. Make two holes in the bottom part of the body
6. Use card box to make wings- insert these into the sides of the body
7. Use two pieces of wood to make the beak and use a knife to shape it appropriately
8. Take two sticks and attach card box shaped like the webbed feet of a duck
9. Insert the two sticks in the two holes
10. Attach the beak to the head
11. Attach two buttons for the eyes
12. Glue up the attachments
13. Paint the model with appropriate colors

SUGGESTIONS FOR ASSESSMENT

Ask the students to

- Make statements about the model
- State the color of the model
- Identify / name / describe the model
- State the habitat of the model
- Name and identify (by touching or pointing) the different parts of the body of the model
- Count the number of legs, eyes on the model
- Explain the uses of the animal
- Explain what the animal feeds on
- Explain the similarities and differences between the modeled animal and other animals in your environment

Extension Activity - Ask the students to

- Draw a picture of a duck
- Make their own simple model of a animal or bird
- Create a storybook about a domestic animal or bird

SAFETY TIPS

Tools Needed:

- Box Cutter / Utility Knife
- Scissors
- Paper
- Pens

If you are using a box cutter or utility knife, remember to extend the blade of your knife only as far as necessary to cut through the cardboard. Always use some scrap cardboard or wood under the material you are cutting to avoid damaging the tabletop. Remember to cut slowly. Many smaller cuts are easier to manage than attempting to cut through all the layers of cardboard at once! If you are using scissors, remember to cut slowly and to carry the scissors by holding them by the blade.

Notes

Sample Resource 9.7 House
MODEL OF REGIONAL HOME

RESOURCE DESCRIPTION

You can create a model of a house made from recycled card box, sticks, reeds, ash, paint and glue. The model is representative of current types of houses found in the context (rural Tanzania). It is also representative of what is considered modern housing especially in rural areas where some traditional types of housing like the manyatta (made from clay, cow dung and sticks) or round mud houses may still be seen.

COMPETENCE ADDRESSED

- Identifying and naming things
- Describing things
- Counting
- Grouping things with similar characteristics e.g. shape or color
- Expressing similarity
- Expressing location
- Expressing quality in terms of size
- Naming, listing, explain characteristics of things, draw and make models of things
- Describing the habitat of people
- Keeping the environment clean and safe
- Drawing and cutting plane figures quadrilaterals, triangles, circles
- Measuring length of figures and objects
- Explaining properties of rectangles, squares and triangles
- Finding perimeter and area of squares and rectangles
- Recognizing types of angles – acute, right
- Understanding and applying skills of pictorial art, decoration and modeling
- Drawing shapes and things using templates
- Matching shapes and templates
- Modeling with clay
- Decorating models
- Drawing pictures of real objects
- Painting using water colors

OBJECTIVE(S)

- Understand the basic needs for shelter and family life
- Promote discussion on health and sanitation
- Promote discussion of regional lifestyles
- Promote discussion of lifestyle and how it changes by environment and climate

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

- Use the house model
- To develop vocabulary in both English and Kiswahili
- To practice counting
- To practice recognition of shapes
- To practice recognition of colors
- To practice measurement of length, width, perimeter and area
- To generate discussion on the environment, conservation and care
- To generate discussion on habitats
- To generate discussion on development
- To generate discussion on modeling
- To practice the use of descriptive words
- To generate discussion on interdependence of human beings and the other things in the environment

DETAILED STEPS

1. Some of the materials needed to make this model can be sourced from the environment at no cost or low cost for instance, recycled card box, sticks, reeds and ash. Paint and glue may be purchased.
2. First collect all the materials needed.
3. Draw a sketch of the intended model (to take care of the detail required).
4. Cut out rectangular pieces of card box for the front and back parts of the house
5. On these pieces, draw the designated positions of windows and doors
6. Cut three sides of the outlined windows and doors, leaving the side that would be connected to the 'wall' so that the 'doors' and 'windows' can be 'opened' and 'closed'. This is helpful as it provides opportunities for more activities and learning of vocabulary.
7. Using the reeds, make a skeletal frame of the house.
8. Cut out another piece of card box for the roof.
9. Peel off the paper on one side to have a corrugated surface
10. Use glue and sticks to attach the card box pieces on the frame
11. Mix some ash with water and paint the house model- this hardens the card box and also preserves it from termites
12. Let the model dry
13. Choose the paint for the house and paint the model
14. Cut a piece of the card box to act as the base (and floor) of the house.
15. Paint this with ash as well and let it dry
16. Attach the base to the rest of the model

SUGGESTIONS FOR ASSESSMENT

- Make statements about the model
- State the colors on the model
- Identify/ name/describe the model
- Name and identify (by touching or pointing) the different parts of the model
- Count the number of windows, sides, angles, shapes, etc. on the model
- Explain the uses of the house
- Explain what real houses are made of
- Explain the similarities and differences between the modeled house and other houses in your environment

EXTENSION ACTIVITIES

Ask the students to

- Draw a picture of a house
- Make their own simple model of a house

SAFETY TIPS

Tools Needed:

- Box Cutters / Utility knives
- Scissors
- Paper
- Pens

If you are using a box cutter or utility knife, remember to extend the blade of your knife only as far as necessary to cut through the cardboard. Always use some scrap cardboard or wood under the material you are cutting to avoid damaging the tabletop. Remember to cut slowly. Many smaller cuts are easier to manage than attempting to cut through all the layers of cardboard at once! If you are using scissors, remember to cut slowly and to carry the scissors by holding them by the blade.

Notes

Sample Resource 9.8
Creating Story Books
SIMPLE FOLDED BOOKS

RESOURCE DESCRIPTION

Children learn to read when they have their own books to hold and turn the pages at their own pace. Often classrooms in challenging contexts struggle to have enough books for all the children – especially books that are culturally appropriate, relevant and tat their individual reading levels. You can create books for your students that tell local stories. The children can write their own stories as well and illustrate your stories and the stories they write together.

COMPETENCE ADDRESSED

- Basic literacy
- Caring for books
- Connection between words and illustrations
- Importance of written stories
- The parts of books – cover, pages, illustrations, words

OBJECTIVE(S)

- Understand the importance of book
- Foster a joy in reading
- Foster a joy in writing
- Foster an understanding of local stories

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

- Read the Book When You Give Children Books (see Handout #2)
- Create one large book using chart paper
- Demonstrate to the children how to read a book
- Point to the words and the illustrations
- Create books for your students to illustrate
- Teach the children to make their own books. Consider having older children help younger children to write books for your school library
- Consider having elders come into your classroom and tell stories that you can write into stories for

the children to illustrate

DETAILED STEPS

1. Select either chart paper (for large books) or A3 paper for smaller, individual books
2. Follow the steps following this resource to the make a book Handout #1: Quick Folded Book
3. (https://wvde.state.wv.us/strategybank/DirectionsforFoldedBooks.html - Quick folded book)
4. Once the book is folded, create a cover and then write the story on the remaining 6 pages.
5. Use the last page as a back cover
6. Number the pages, not including the front and back cover so children get a sense of page numbers and how to turn the pages of a book.
7. Numbering the pages supports the idea of a story sequence of events.

SUGGESTIONS FOR ASSESSMENT

Ask the students to

- Read the book aloud
- Illustrate the pages appropriately, match pictures to the plot, words used, and characters and setting
- Create their own books
- Illustrate their own books
- Create books for other people's stories

SAFETY TIPS

Tools Needed:

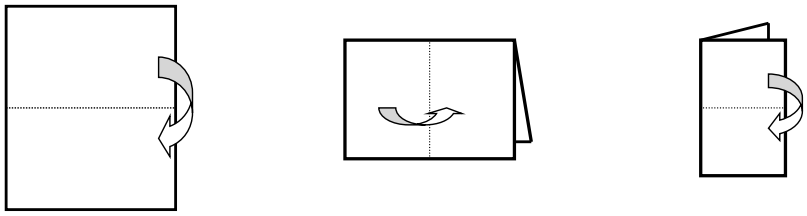
- Scissors
- Paper
- Pens

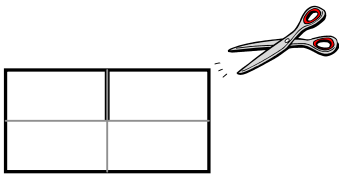
If you are using scissors, remember to cut slowly and to carry the scissors by holding them by the blade.

Sample Resource 9.8 Creating Story Books
SIMPLE FOLDED BOOKS
HANDOUT #1: QUICK FOLDED BOOK

Quick Folded Book

Each student will use a sheet of A4 copy paper. Holding the paper (portrait), fold it in half. The fold it vertically, then again horizontally.

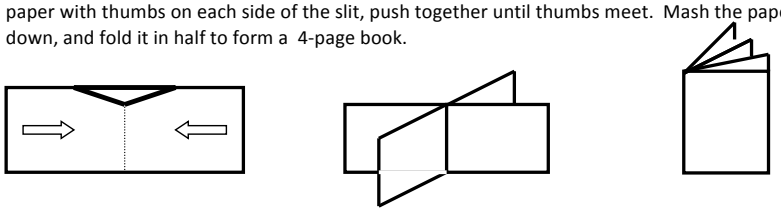




Open the sheet back up to the first fold, then cut from the

top fold to the intersection. This forms a slit in the center of the paper when it is opened flat.

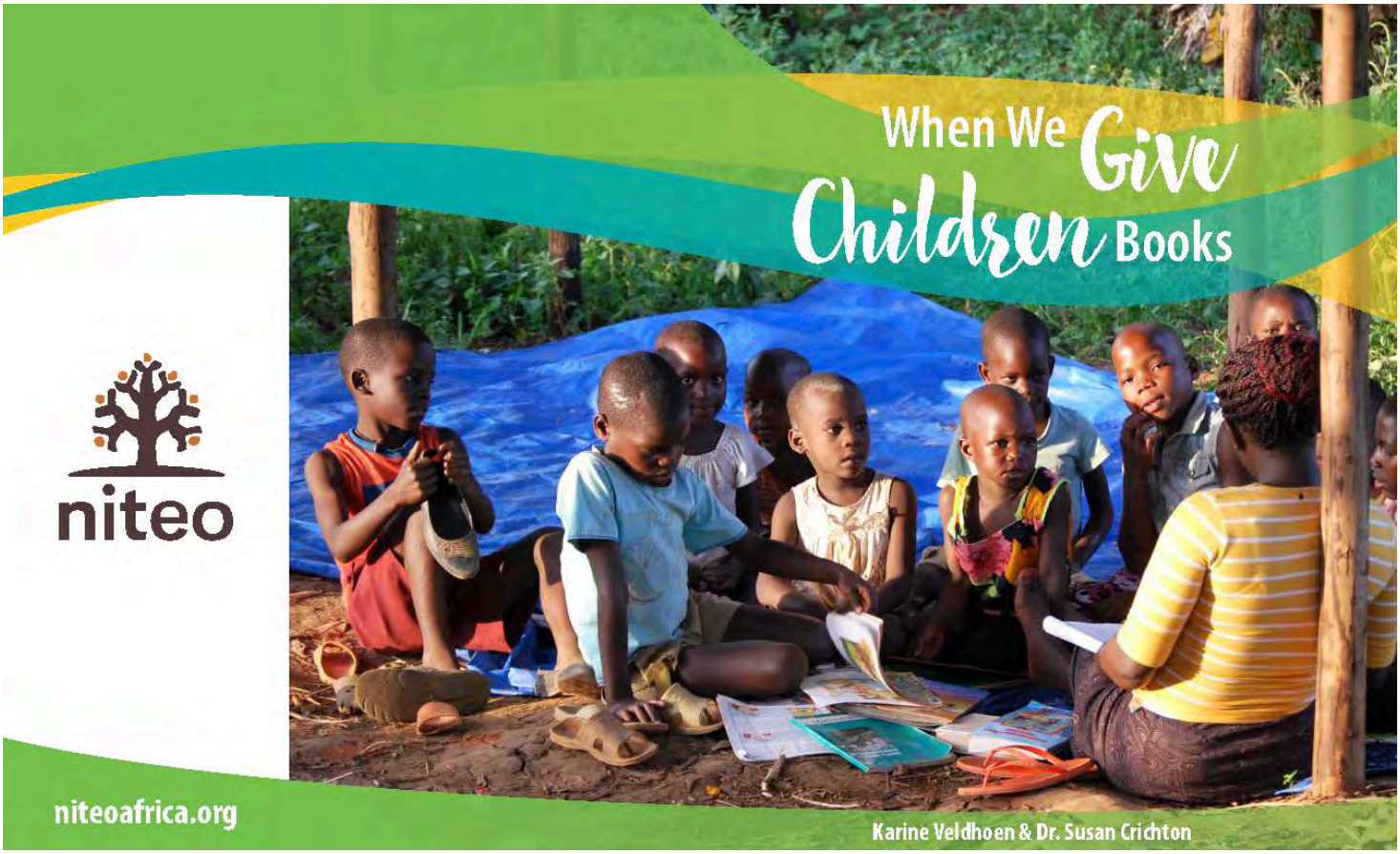
Open the sheet flat and fold it vertically. The sides of the slit will try to separate. Holding the paper with thumbs on each side of the slit, push together until thumbs meet. Mash the paper down, and fold it in half to form a 4-page book.



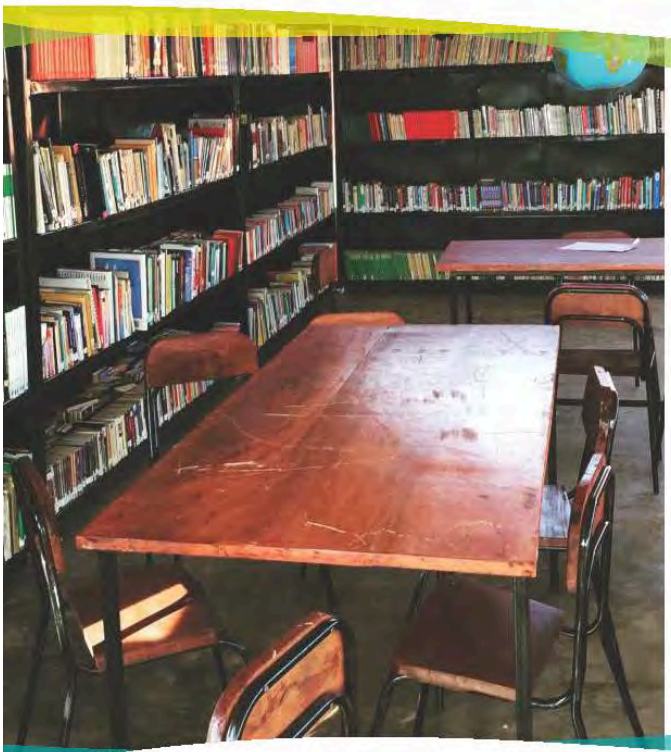
To make a book with more pages, place a staple in the spine of the book, then cut on each of the folds to open up the book and create an 8-page book.

To make other types of books, please explore
https://wvde.state.wv.us/strategybank/DirectionsforFoldedBooks.html

Sample Resource 9.8 *Creating Story Books*
SIMPLE FOLDED BOOKS
HANDOUT #2: WHEN WE GIVE CHILDREN BOOKS



When We Give Children Books



When we give children books,
we help them read their world.

When we give children books, we share the joy of reading. We invite children to find their place and come close to us, so they can listen and see.

We welcome them and help them to feel comfortable. The children learn to listen closely so they can begin to hear the words as they come alive in our reading. We help children become curious about what is on each page.

When we give children books, we have a choice of how to guide their literacy experiences. We want the children to feel successful. Our choices include:

1. Reading to the children - reading aloud to the children
2. Reading with the children - reading the words together
3. Echo reading - reading a line then having the children repeat it back
4. Taking turns reading - trading off line by line or page by page

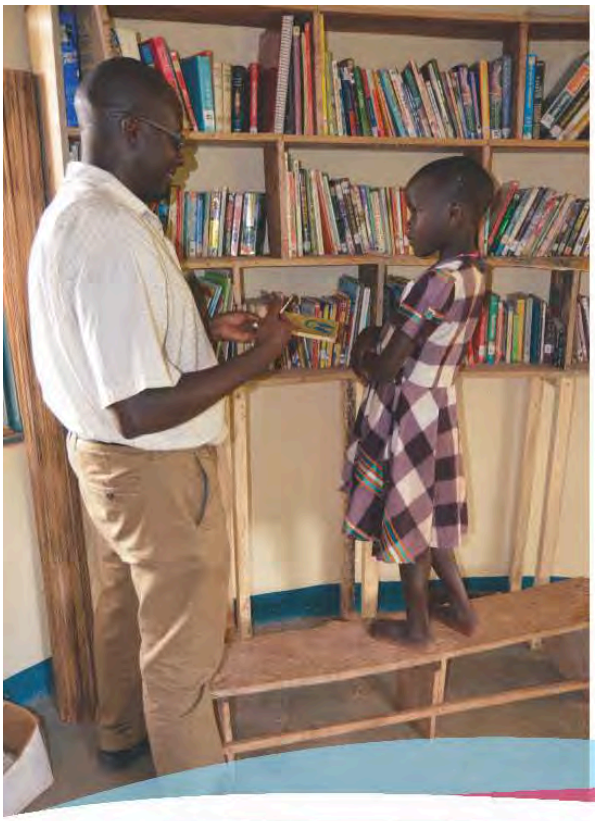
When we give children books, we are inviting them to enjoy the books we love and want to share. We hold the book in such a way that everyone can see the positioning of the words, pictures, and ideas that fill the pages.

When we give children books, we link written words to spoken words. We use our finger to point and track our progress across the page, connecting words with letters and sounds. Our tracking models to the children how to read a book new to them. Tracking words helps children build their understanding, word by word, page by page.

When we give children books,
we read with an expressive voice, face, and actions - almost acting out the words on the page. It helps if you read the book ahead of time, so you know what is coming on the next page.

When we give children books,
we present a book with creativity and we use prompts or found items to support understanding. We ask good questions that can not be answered with a simple yes or no. Good questions require children to stop for a moment and think hard.

When we give children books, we encourage them to read with friends. Children share words they know, talk about words they do not know, and discuss the pictures. Children naturally want to build understanding together.

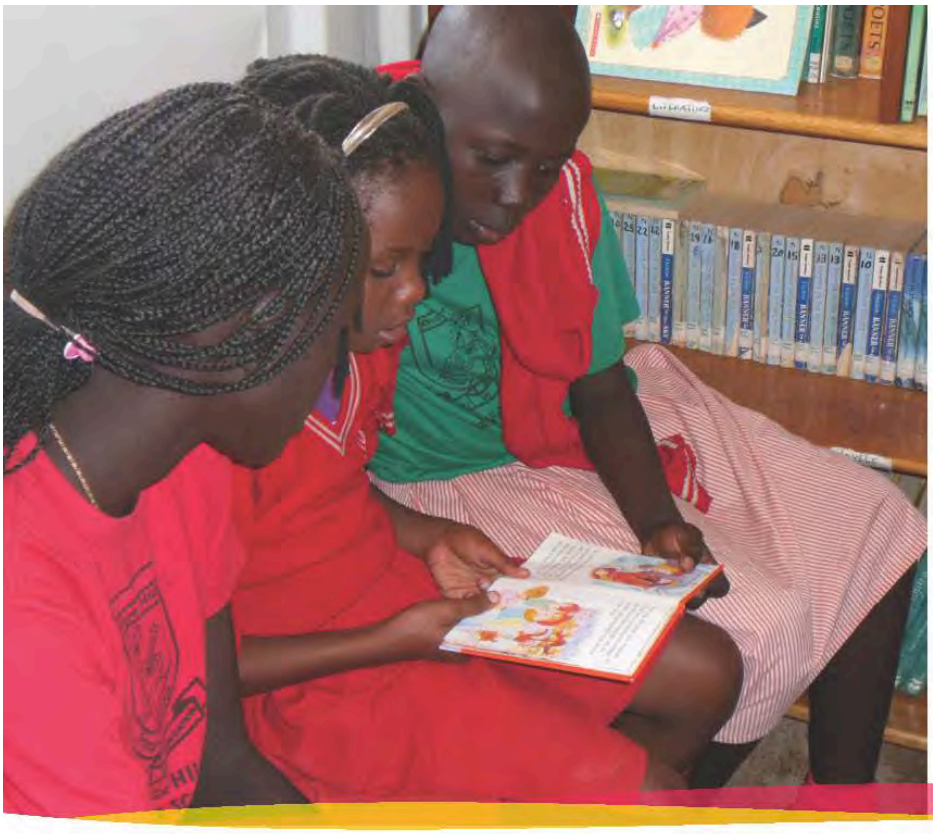


When we give children books, we help them foster the skills they need to become independent, lifelong readers.

We help them select appropriate books to read alone and to read with their friends and families. Children choose books with subjects they enjoy and words they can decode. It is through selecting appropriate books that children advance their skills and understanding.

When we give children books, we create an opportunity for them to play with words drawn from the text.

We can explore sounds, spelling, patterns, definitions, and translations. Children learn that words are fun and carry a variety of meanings.



When we give children books, we encourage them to become great readers. Children become great readers by listening to fluent readers who can read with ease and understanding. We must encourage children to read and re-read. We can pair good readers with less skilled readers. It is through re-reading that children gain confidence and fluency.

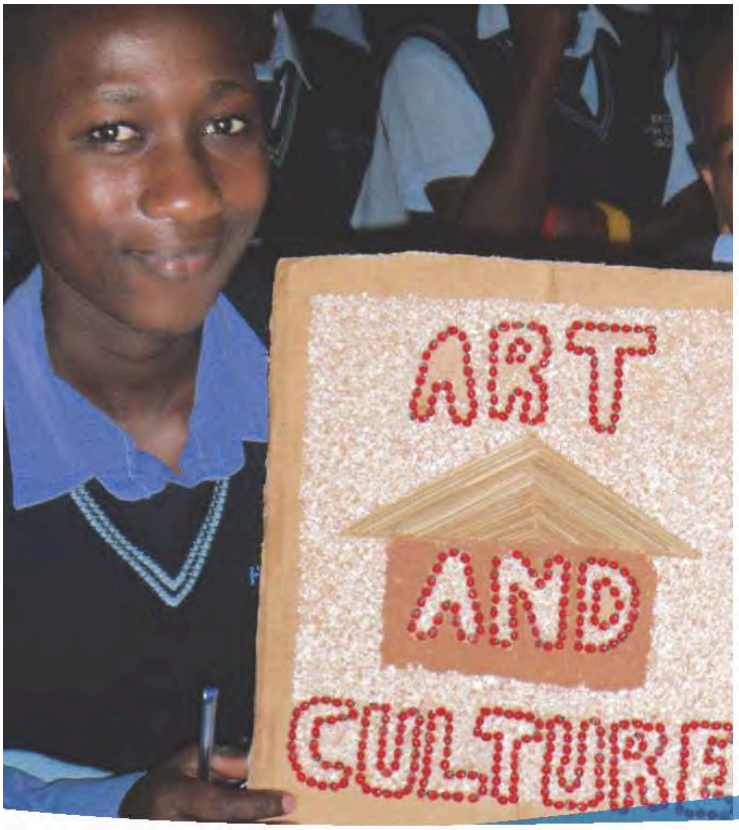
When we give children books, we foster the development of good readers. Good readers use many strategies to make meaning. They are actively engaged in the reading process. They participate appropriately. They use their body and voice to show they have understood what was read.

When we give children books, we expand the literacy experience by encouraging the children to respond to what was read by writing and drawing. The children should be given an opportunity to link their writing or drawing to what was read.

When we give children books, we invite them to draw on their own experiences and make connections between their lives and the ideas within the pages. Good readers can make additional connections with books they have already read and the world around them.

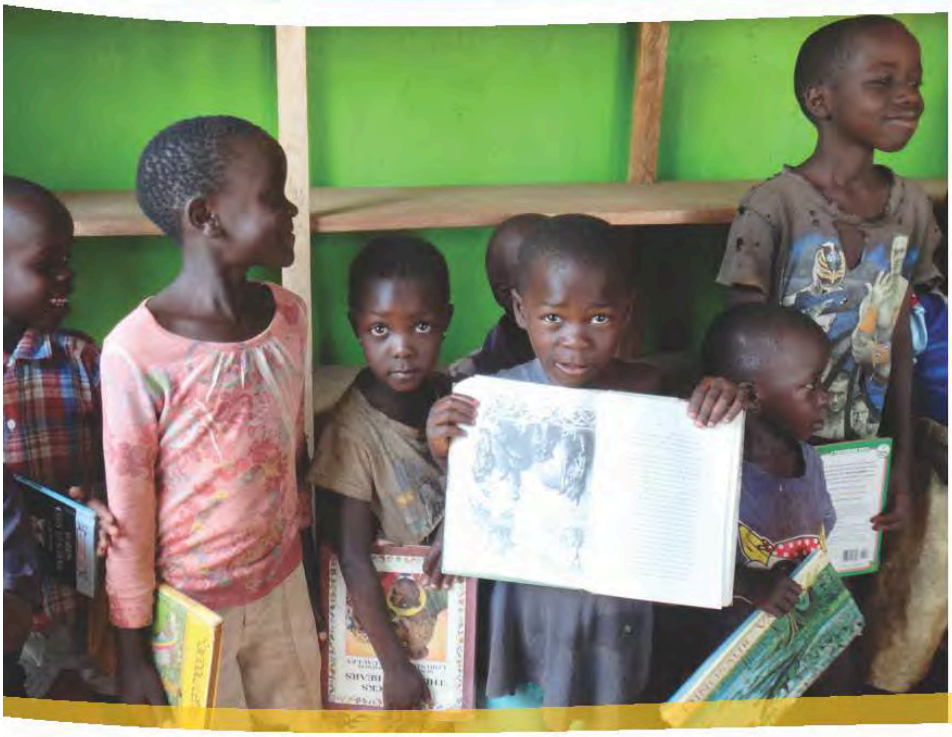
When we give children books, we ask the child to consider evidence in the words and pictures. The children learn that the author gives them clues, but requires them to come to their own conclusions.

When we give children books, we invite the child to think and question as they read. Thinking and questioning allows them to explore a story beyond what is immediately obvious. We can model questioning in our discussions with the children.



When we give children books, we help them create pictures in their minds. These pictures foster deeper understanding and comprehension. We call this visualization.

When we give children books, we invite them to consider the possibility of change, to think about other people, places, ideas, and ways of being in the world. This allows children to transform their thinking and perspectives. We can ask important questions like, "What have you read today that changed your thinking?"



When we give children books, we must provide closure to the literacy experience. We do this by providing time for the children to reflect on their learning before moving out into the world, changed.

When we give children books, we must model that books are treasures to be cared for. In order for our books to be shared with others for a long time, we need clean hands. We need to turn the pages by their corners and hold the books carefully.

When we are finished, we must re-shelve the books with the spines facing out so others can find them easily.

We recognize there are additional literacies necessary to help children be successful in an increasingly global and complex world.

Niteo believes essential literacies for sustainable living and thriving include:

1. Reading and Writing
2. Numeracy
3. Problem Finding and Problem Solving

Glossary

Comprehension
The ability of the learner to make meaning from the text.

Conclusions
A judgment or decision reached by reason.

Connections
Text-to-self connections are highly personal connections that a reader makes between a piece of reading material and the reader's own experiences or life. Fluent readers may also make text-to-text and text-to-world connections.

Expressive reading
To read a text with feeling to match the meaning. In order to match the proper expression to each word or phrase, you have to understand both the meaning of the words and the grammar of each sentence.

Fluency
The ability to read a text accurately, quickly, and with expression. Fluency is important because it provides a bridge between word recognition or decoding and comprehension. Fluency allows a learner to make meaning from what they read.

Independent
When an individual is able to think, act and pursue their own studies on their own, without the same levels of support you receive from a teacher at school.

Literacy
An active and broad-based learning process, with the cognitive skills of reading and writing at the center. Educators focus on ways in which individual learners, especially children, make sense or construct meaning of their learning experiences.

Numeracy
The ability to process, interpret and communicate numerical, quantitative, spatial, statistical, and even mathematical information in ways that are appropriate for a variety of contexts.

Problem finding
A means to discover and define problems within design thinking process.

Problem solving
The purpose of a design thinking process which includes empathizing, discovering, and experimenting to yield new innovations.

Strategies
Literacy learners construct meaning by interacting with text; as individuals read, they use their prior knowledge along with clues from the text to construct meaning. This means that they have purposes for their reading and pay attention to both their "speaking voice" and their "thinking voice" as they read. Fluent readers use the strategies: connect, question, visualize, infer, and transform.

Tracking
When young readers point with a finger to help their eyes move left to right and to read word by word. Fluent reading requires the reader to move left to right across a line of print and across words, matching voice to print without the support of a pointing finger.

Understanding
The essence of learning is to apply and transfer knowledge, skills, and competencies, so learners become independent problem-solvers.

Visualizing
The ability to create pictures in our heads based on text we read or words we hear. It is one of many skills that makes reading comprehension possible. This method is an ideal strategy to teach to young students who are having trouble reading.

Resources

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A Manifesto on Literacy

By Karine Veldhoen and Dr. Susan Crichton

Literacy liberates. Literate children become critical and creative thinkers, meaning makers, problem finders and problem solvers. Literate children become change makers in an increasingly complex world.

Books are for everyone.
Very young children acquire language through conversation with their families and friends. In song and verse, children find joyful ways to communicate and connect. In books they begin to see and hear the connection between words and ideas.

Connections can start with reading together. Infants and toddlers enjoy being read to. Why? Because the reader is creating rich and relational opportunities and possibilities, by introducing patterns, images, sounds, shapes, and connection.

Gradually the young child begins to recognize spoken words can take the shape of written language. Through the complex literacy learning of listening, speaking, reading and writing, children become meaning makers and they learn to read words and worlds in increasingly sophisticated ways.

Young learners need frequent practice in meaning making along their journey. A famous proverb says, "A book is like a garden, carried in the pocket."

Children must have consistent opportunities to explore the meaning of text.

Books are joyful journeys to places imagined and real.

Open Books. Open Minds. Open Doors.

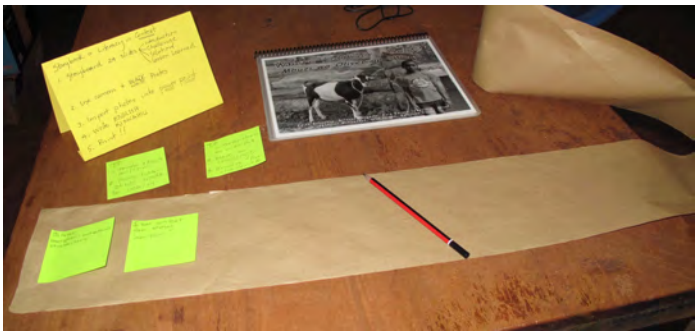
Over time, the child learns books are joyful invitations into the imagination, into new realities, and into unknown realms. Books are explorations into the light and shadows of our humanity, with opportunities to learn and grow through the experiences of others. Books open the breadth of human knowledge, inviting both creative and critical thinking.

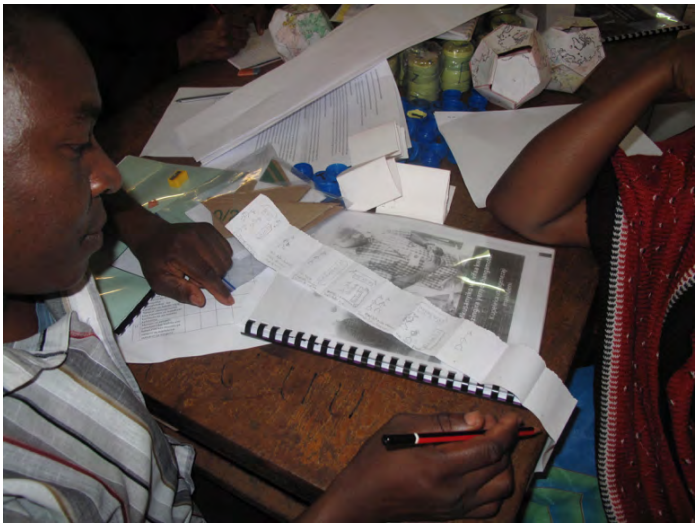
Books invite transformation!
When we give children books, we are empowering them to explore the wideness of the world, develop a sense of personal identity, and encourage a sense of belonging within the global context.

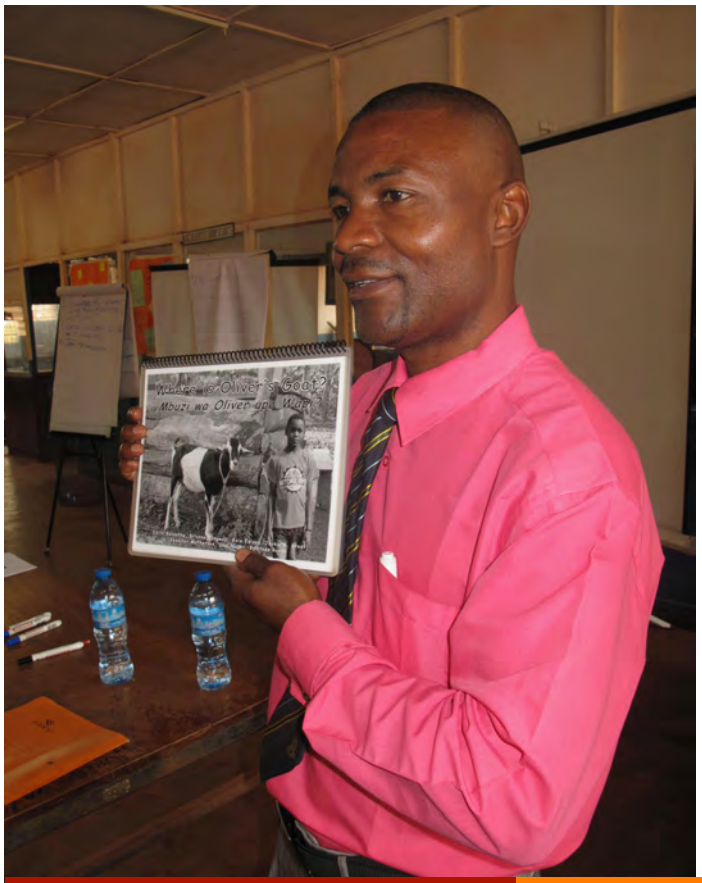
Seeing is the first step in transforming. Transforming begins as the child discovers new literacies.

> *If I am literate, then I am empowered and I can think differently. I can think differently in a process called design thinking. To think well, I need to focus my thinking. I can question, be empathetic, and human-centered in my approaches to the contextual problems I face. I can transform my reality.*

In an increasingly complicated and interconnected world, there are multiple literacies children need and foundational to thriving with all literacies is reading and writing.







Sample Resource 9.9
Creating Picture Books
USING PHOTOGRAPHS

RESOURCE DESCRIPTION

Children learn to read when they have their own books to hold and turn the pages at their own pace. Often classrooms in challenging contexts struggle to have enough books for all the children – especially books that are culturally appropriate, relevant and tat their individual reading levels. You can create books for your students that tell local stories.

Local storybooks help children to read culturally relevant material that relates to their daily life experiences. Local stories, illustrated with detailed black and white photographs, help children to learn additional words, phrases and sentences. The use of photography helps to illustrate the story in more detail, allowing the experienced reader to add additional words and phrases beyond those in the story.

Please see the story *Where is Oliver's Goat?* This book was created in Arusha, Tanzania and is a good example of a locally developed book. (see ***Handout #1).***

The steps required to create this resource include:

- Storyboarding the plot, characters and setting
- Photographing the illustrations
- Assembling the story using PowerPoint software on your Resource Centre computer
- Printing the pages of the story and either assembling them into a A4 size book or printing the individual pages onto A3 paper and displaying them on your classroom wall.

COMPETENCE ADDRESSED

- Basic literacy
- Caring for books
- Connection between words and illustrations
- Importance of written stories

- The parts of books – cover, pages, illustrations, words
- Learning to read from words and pictures
- Learning to read independently in Kiswahili and English
- Learning to read aloud

OBJECTIVE(S)

- Understand the importance of books
- Foster a joy in reading
- Foster a joy in writing
- Foster an understanding of local stories

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

- Read the Book When You Give Children Books (see Sample Resource 9.8, Handout #2).
- Read the story Where is Oliver's Goat to your class. Observe the children's response to a book in both Kiswahili and English. Observe the value of a book having repeated words and phrases (see Handout #1: Where is Oliver's Goat).
- Develop a story yourself. Follow the detailed steps below.
- Read the book you have created to your students. You can post each page of your story on the classroom wall so the children can continue to read the pages.
- Work with your students to create their own stories.

DETAILED STEPS

Creating a Storyboard

1. All good stories have a clear beginning, middle and end, like the story of *Where is Oliver's Goat*?

    1.1. A storyboard helps you to organize the story and keep the action (plot) of the story easy to follow. Many good stories have 24 pages or less. We recommend that your first stories consist of no more than 24 pages. We also suggest to keep your story is only 24 pages long, that you have the action take place in 1 or 2 settings and involve only 2-3 main characters.

2. Think about a short story idea. Maybe it is the story of a Mother who takes her daughter to the market and gives her some small money to spend. At the market the Mother introduces the daughter to friends and points out fruits and vegetables. The daughter must decide what to buy.

3. This story idea allows the reader to think about the value of money. It teaches the proper way to meet and greet older people. It also introduces the names of fruit and vegetables.

4. Make a storyboard of your story idea. Take a piece of paper and fold it into 24 sections. See the example below.

5. The storyboard is important because it helps you organize your story and make sure it is told well. It also helps you think through the photographs you need to take and helps you plan where you need to go and who or what needs to be in each picture. You want to think about how you are going to photograph each of the pictures. By using photography as illustration for your story, your story will probably be fairly realistic.

6. Below are suggestions for the sections of the story:
    6.1. The first section is the cover of the story and has the title
    6.2. The last section is the back cover
    6.3. Sections 2 – 3 set the scene for the story and introduce the characters
    6.4. Sections 4 – 5 add detail to the story idea that set up the actual plot and introduce a dilemma or problem
    6.5. Sections 6 – 14 unfold the plot. If your story has a problem the characters have solve, you need to introduce that problem by Section 8 or 9 so there is time to find a solution.
    6.6. Section 15 the dilemma or problem is almost solved
    6.7. Section 16 – 21 the plot works its way to a close conclusion
    6.8. Section 22 the story might provide a lesson or a moral
    6.9. Section 23 provides credits – who wrote the story, who is in the pictures, who needs to be thanked for their assistance
    6.10. Section 24 is typically left blank as it is the back cover

7. When the storyboard is complete, you are ready to take the pictures. Use the storyboard as a way of arranging who you need to photograph and the location, time of day, necessary props. Either use the camera that you have on your phone or other device or see if your Resource Centre has a camera you can use.

8. Once you have taken all the photographs you need, upload the photographs to the computer in your Resource Centre or Maker Space. The Maker Space Tutor can help you.

9. Use PowerPoint, a software program, to organize, write, and edit your story. The Tutor can help you find the right Power Point slide for each page of your storyboard. (see ***Handout #2:*** *Suggestions for PowerPoint Slides)*

10. Insert your photographs. You can use PowerPoint to edit the photographs. Crop lets you cut out necessary content. The Color tool lets you change your colour photographs to black and white. This is important because many printers typically only print in black and white. IF they do print in colour, colour printing is often very expensive. The Corrections tool can help improve the quality of your photograph. (see ***Handout #3:*** *Tips on Editing Photographs)*

11. Once your photographs are edited and placed on the correct PowerPoint slide, you can write your story text on each slide. You may want to write your stories in both Kiswahili and English, depending on the level you teach.

12. Look again at the story, *Where is Oliver's Goat*. It provides an excellent example of a simply story well told using local pictures to illustrate the action.

SUGGESTIONS FOR ASSESSMENT

Ask the students to

- Read the book aloud
- Illustrate the pages appropriately, match pictures to the plot, words used, and characters and setting
- Create their own books
- Illustrate their own books
- Create books for other people's stories

Informal assessment

- Observe the children reading aloud. Ask the children to read to you

Formative assessment

- Note the words the children can decode when they are introduced to the story and record how many additional words they have learned

Summative assessment

- Ask children to read randomly selected pages and note the words they know.
- Cover the pictures and ask the children to read specific words and note comprehension.
- Ask children to find specific words in the text.

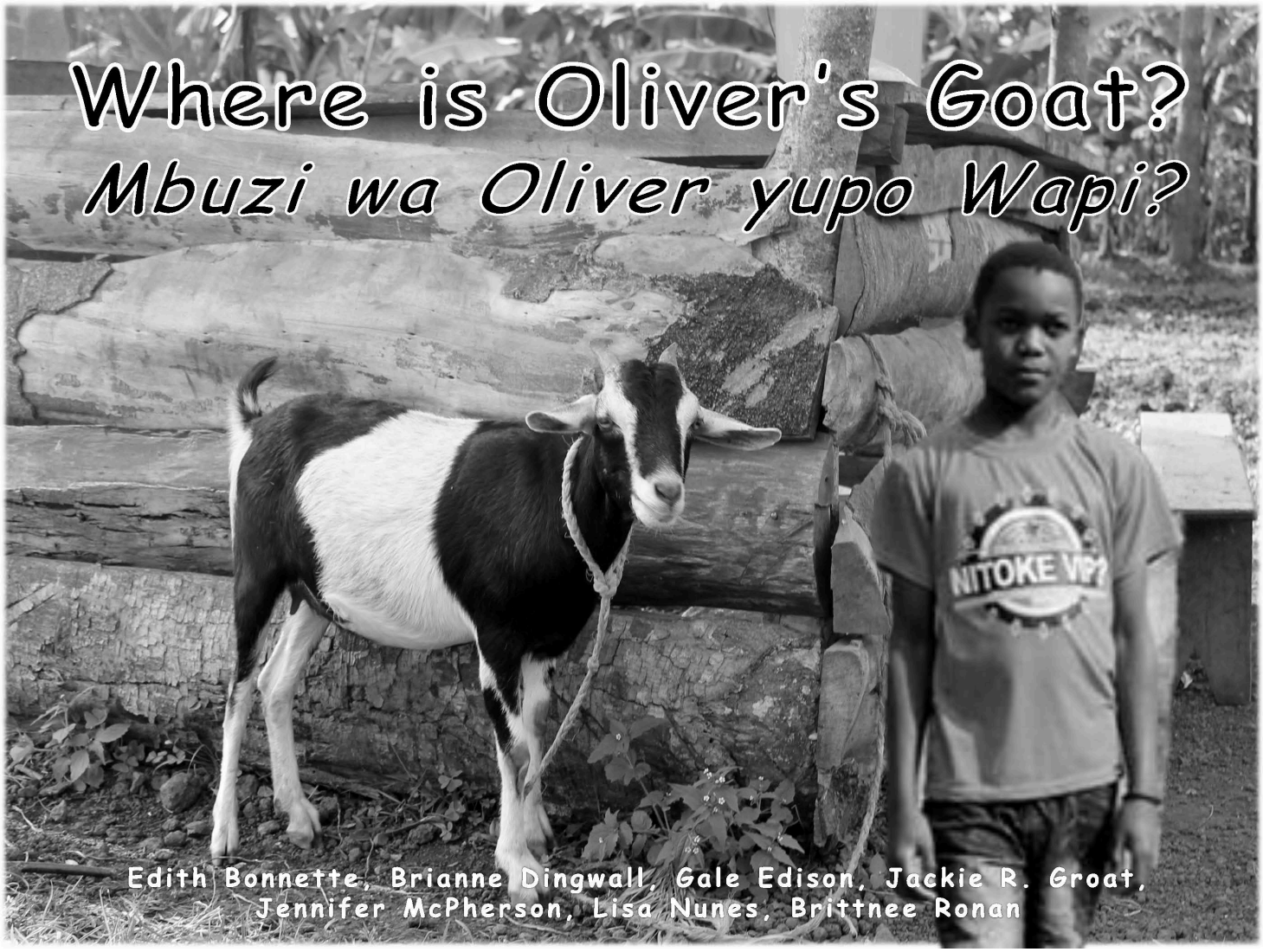
SAFETY TIPS

Tools Needed

- Scissors
- Paper
- Pens

If you are using scissors, remember to cut slowly and to carry the scissors by holding them by the blade.

Sample Resource 9.9 Creating Picture Books
USING PHOTOGRAPHS
HANDOUT #1: WHERE IS OLIVER'S GOAT?



This is Oliver.
Huyu ni Oliver.

He is a boy from Arusha.
Ni mvulana kutoka Arusha.

"Oliver, please take care of the family goat today," says Mother.
"Oliver, tafadhali chunga mbuzi wa familia leo," Mama anasema.

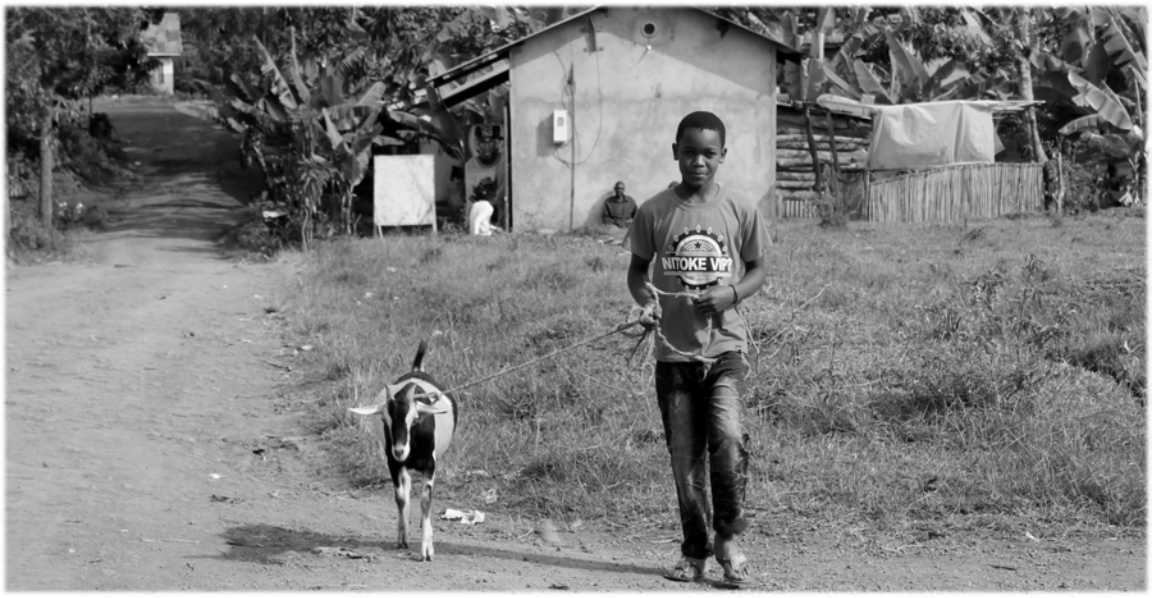
"Yes, Mother."
"Sawa, mama."

Oliver is getting ready to go to the market.
Oliver anajitayarisha kwenda sokoni.

He puts the rope on the goat.
Anamfunga mbuzi kamba.

"Oliver, is the rope on the goat?" says Mother.
"Oliver umemfunga mbuzi kamba?" Mama anasema.

"Yes, Mother."
"Ndio mama."



Oliver is going to visit his friend Diana.
Oliver anaenda kumtembelea rafiki yake Diana.

Diana helps her mother at the market.
Diana hua anamsaidia mama yake sokoni.

"Good morning, Diana. How are you?" asks Oliver.
"Habari za asubui Diana. Unaendeleaje?" Oliver anamuliza.

"Good morning, Oliver. I am fine, thank you," replies Diana.
"Nzuri Oliver. Naendelea vizuri asante," Diana anajibu.

"Oliver, where is your goat?" asks Diana.
"Oliver, mbuzi wako yupo wapi?" Diana anauliza.

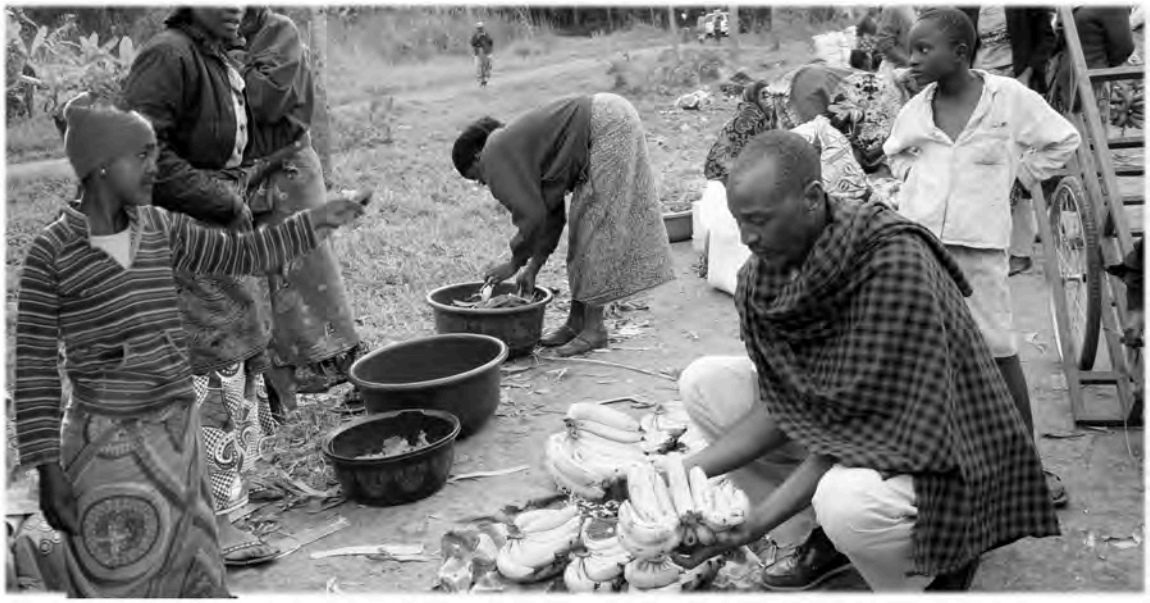
"I do not know," replies Oliver.
"Sijui," Oliver anajibu.

"Diana, please help me find my goat, or I will be in trouble!"
"Diana, tafadhali naomba nisaidie kumtafuta mbuzi wangu maana nitagombezwa!"

"Yes, I will help you."
"Sawa, Nitakusaidia."

"Maybe your goat is at the banana stand!" says Diana.
"Labda mbuzi wako yupo kwenye genge la ndizi!" Diana anasema.

"I see bananas. I do not see my goat," replies Oliver.
"Naona ndizi. Simuoni mbuzi wangu," Oliver anajibu.



"Maybe your goat is at the orange stand!" says Diana.
"Labda mbuzi wako yupo kwenye genge la machungwa!" Diana anasema.

"I see oranges. I do not see my goat," replies Oliver.
"Nayaona machungwa. Simuoni mbuzi wangu," Oliver anajibu.

"Maybe your goat is at the avocado stand!" says Diana.
"Labda mbuzi wako yupo kwenye genge la maparachichi!" Diana anasema.

"I see avocados. I do not see my goat," says Oliver.
"Naona maparachichi simuoni mbuzi wangu," Oliver anasema.

"Maybe your goat is at the carrot stand!" says Diana.
"Labda mbuzi wako yupo kwenye genge la karoti!" Diana anasema.

Diana shouts, "Look, I see your goat!"
Diana apiga kelele, "Angalia, Namuona mbuzi wako!"

"Where?" asks Oliver.
"Wapi?" Oliver anauliza.

"Your goat is at my mother's stand!" says Diana.
"Mbuzi wako yupo kwenye genge la mama yangu!" Diana anasema.

"I am happy. I found my goat!" says Oliver.
"Nina furaha. Umempata mbuzi wangu!" Oliver anasema.

"Thank you for your help, Diana," says Oliver. "You are a good friend!"
"Asante kwa msaada wako, Diana," Oliver anasema, " Wewe ni rafiki mzuri!"

"You are welcome," says Diana.
"Karibu," Diana anasema.

Oliver thinks to himself, "I will always hold onto the rope. I need to take care of my things."
Oliver anawaza, "Nitashilikia kamba kamwe. Nahitaji kutunza vitu vyangu."

Special thanks to:

University of British Columbia Okanagan Education Students
for their field work, photography and other contributions.

Vijiji Foundation
for providing the opportunity for this project to take place, for providing translation and other contributions.

Staff at Moivaro Primary School
for their collaboration and inspiration.

Anisetha Godson (as Diana)
Joseph Ally (as Oliver)

Shukurani za dhati:

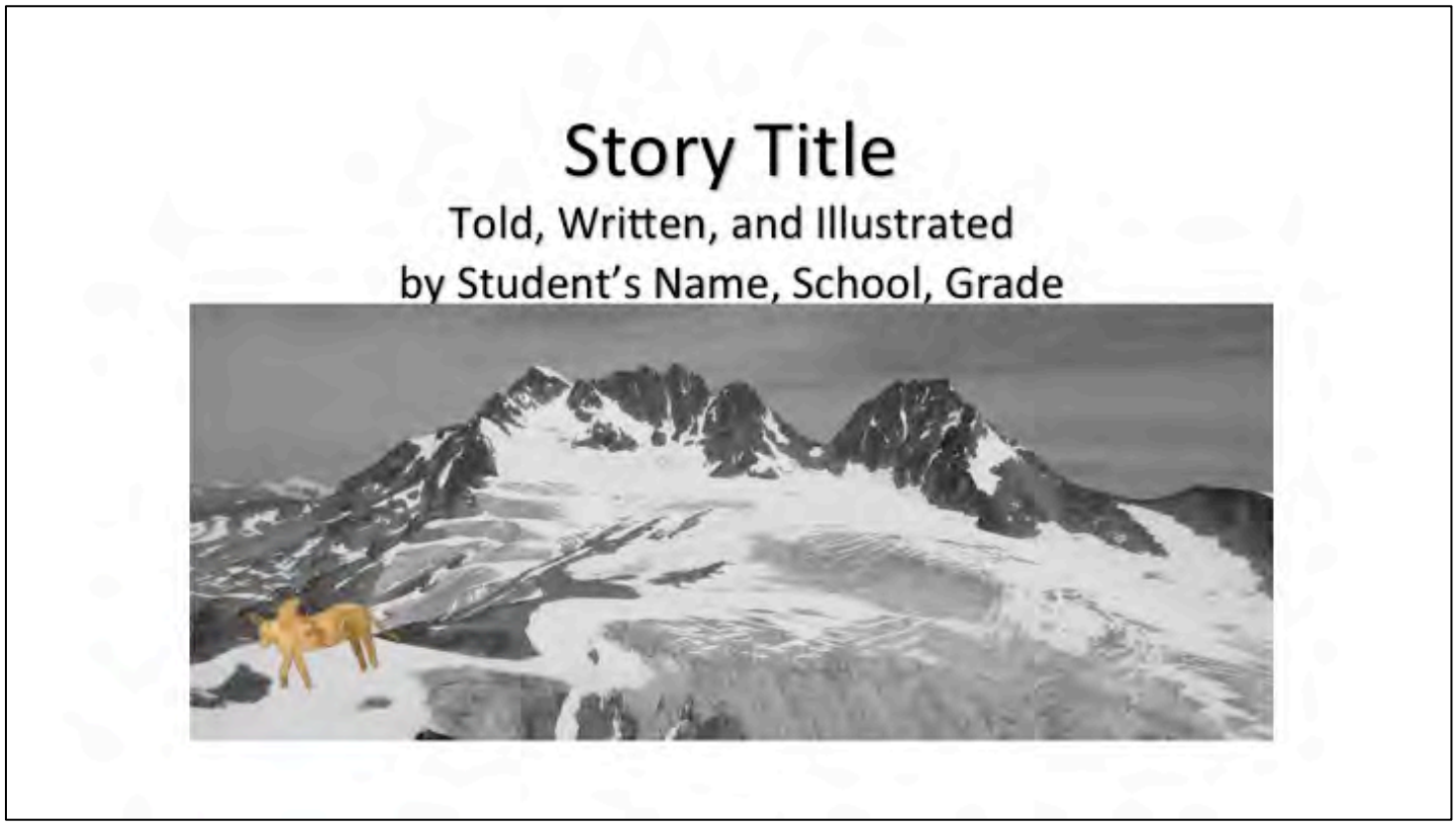
*Chuo kikuu cha **British Columbia** na wanafunzi wa elimu wa **Okanagan** wanashuru kwa picha na kazi yakujitolea. Pamoja na*
*Shirika la **Vijiji** kwa kuwapa nafasi ya kujitolea na mchango wa kutasiri na michango mingine na walimu wa shule ya msingi **Moivaro**, kwa kutafsiri,kupiga picha na michango mingine kwa ujumla.*

Sample Resource 9.9 Creating Picture Books
USING PHOTOGRAPHS
HANDOUT #2: SUGGESTIONS FOR POWERPOINT SLIDES

STORYBOARD SECTION 1 (STORY TITLE)

This is your first PowerPoint slide including

- Story Title
- Who told, wrote and illustrated the story – usually the person(s) who created the Storyboard - might be one student, group of students, or person(s) from your community
- Photograph representing entire story



STORYBOARD SECTIONS 2 TO 22 (STORY)

This is a template slide for the story pages. There should be room left on all sides of the back ground photos and text box. The suggested font is Calibri. The suggested font size is 24.

This is a template slide for the book pages. Their should be room left on all sides of the background photos and text box. This is the text font and size.

→ The text box should not go below this marker

STORYBOARD SECTION 23 (CREDITS)

This is a template slide for your *second to last page.* Remember the last page is usually left blank. Copy the Story Title and any Text from Storyboard Section 1 (STORY TITLE). The remainder of this page acknowledges everyone who contributed to the creating of the storybook.

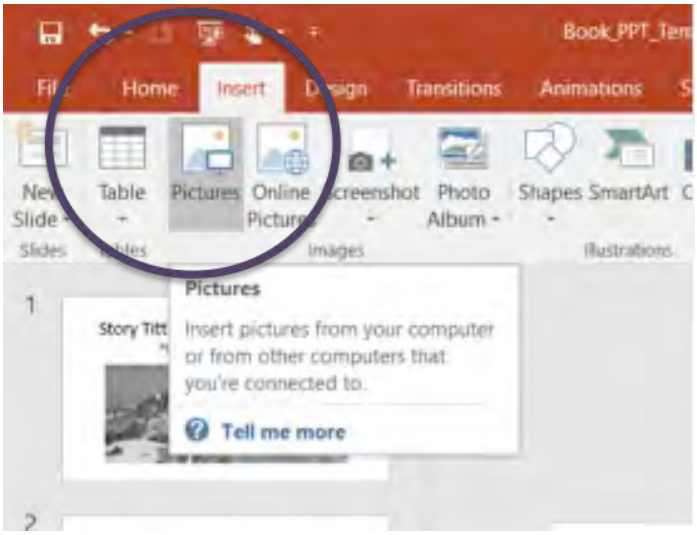
Story Tittle: Told, Written, and Illustrated by Student's Name, School, Grade

Student 1	Student 7	Student 13	Student 19	Student 25	**Assisted by:**
Student 2	Student 8	Student 14	Student 20	Student 26	Teacher 1
Student 3	Student 9	Student 15	Student 21	Student 27	Teacher 2
Student 4	Student 10	Student 16	Student 22	Student 28	Teacher 3
Student 5	Student 11	Student 17	Student 23	Student 29	
Student 6	Student 12	Student 18	Student 24	Student 30	Etc…
Etc…	Etc…	Etc…	Etc…	Etc…	

Sample Resource 9.9 Creating Picture Books
USING PHOTOGRAPHS
HANDOUT #3: TIPS ON EDITING PHOTOS

Tip #1: Preparing your student's art work for a photo

Before photographing your student's artwork, it will be helpful to outline the objects in the drawing with a dark felt, colored pencil or pen.



Tip #2: Insert Photo

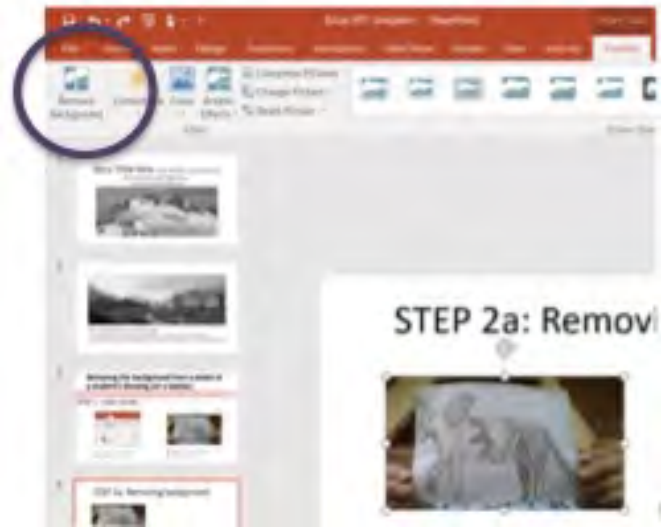
After opening Microsoft PowerPoint, choose the slide you want to insert your photo, then

- Click the ***Insert*** Tab
- Click on ***Pictures***
- Find the photo of your student's artwork
- Insert photo onto PowerPoint slide

Tip #3: Removing Background

Part A

- Double click on the photo
- Click on ***Remove Background***

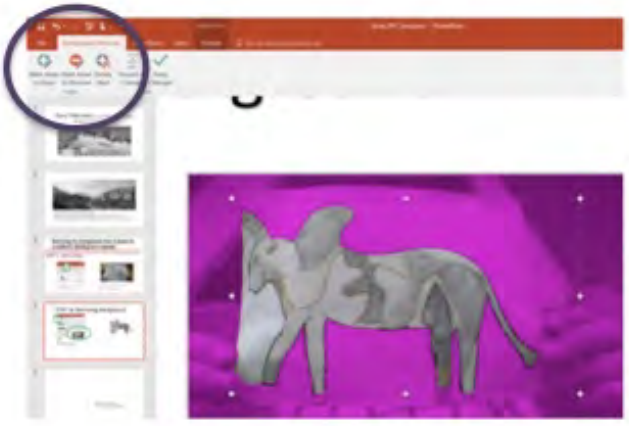


Tip #3: Removing Background

Part B

Your photo will look similar to the illustration

- Use the ***– (minus)*** or ***+ (plus) buttons*** to remove the background

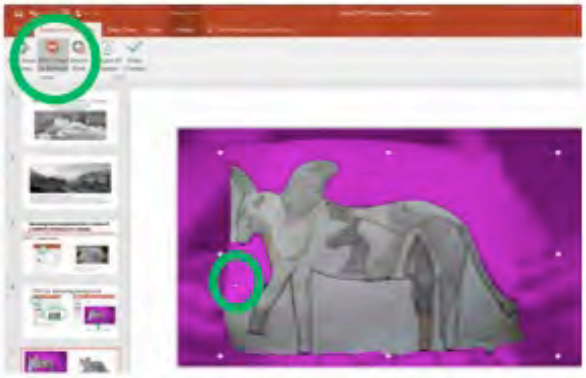


The next 3 pages show further tips as you become more familiar with Microsoft PowerPoint and its functions.

1

→ Resize the box so the drawing is inside

2



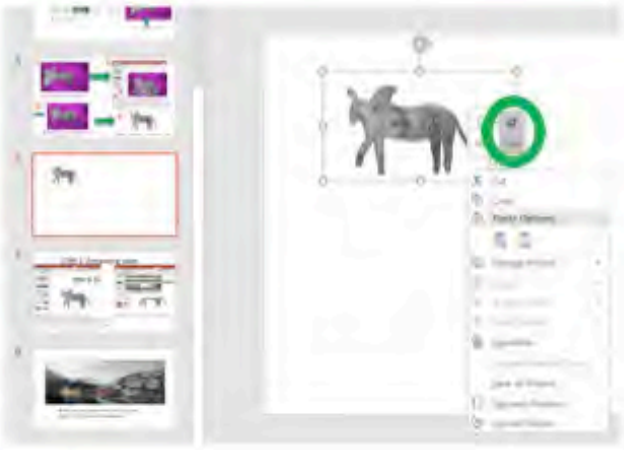
→ If there is still more background to be removed you need to click on the "Mark Areas to Remove" tool above and then click on the areas in the photo you want to remove

3

→ You may have to click many times to remove all the background

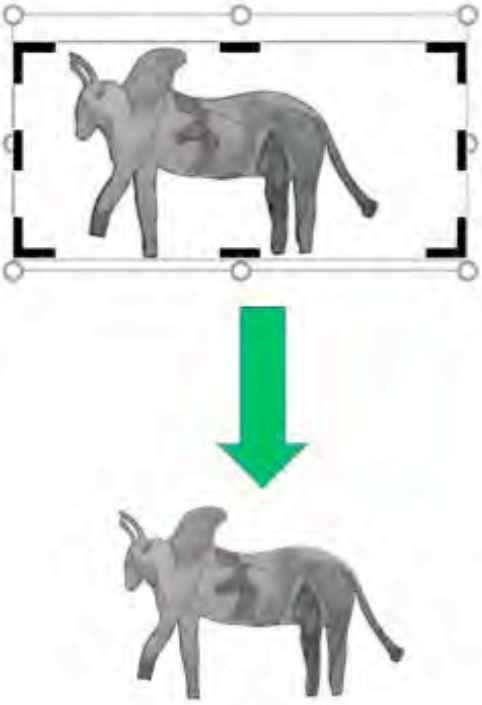
4

→ Finally, click outside the picture frame to finish

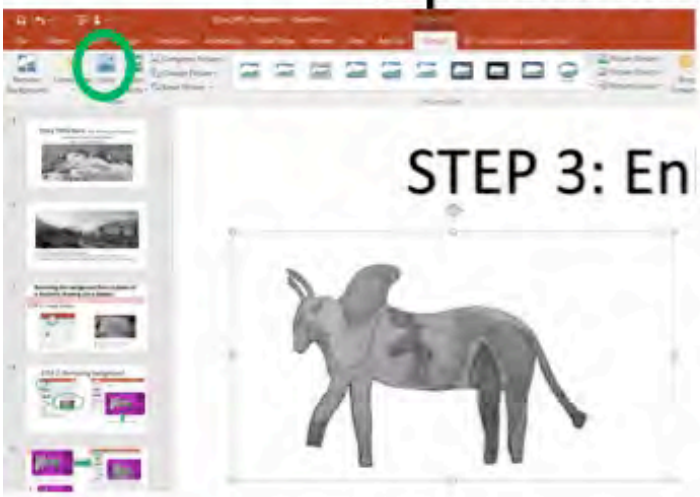


→ It is helpful to "crop" each drawing because it is hard to move them around on each slide when there are many drawings

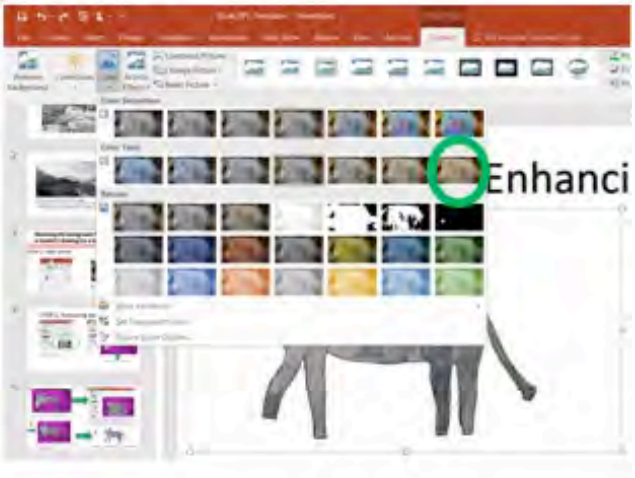
→ To do this: right click on your photo of the drawing and select the "crop tool, " then resize the frame by clicking and Dragging the black lines on the frame.



Tip: Enhancing color



→ Background photos are in black and white so it is helpful to change the color of the students drawing so it is easy to see.
→ To do this : start by double clicking your photo of the drawing that has the background removed, then click on the "color" tool above.



→ Now select the color enhancement that you like

→ This gives you a picture that shows up much better on a black and white background

STEP 4: Flipping drawings

→ You may want to flip a drawing so it makes more sense in the context of the plot of the story.
→ To do this : start by double clicking your photo, then click the "effects" pentagon icon on the right, then click the "3-D Rotation" tab, then type in 180 into the box.

STEP 5: Rotating drawings

→ You may also want to rotate your photo of the drawing
→ To do this: Click on your drawing and then click on the circular arrow and spin to get your desired angle

Sample Resource 9.10
Building a Solar Oven
SOLAR ENERGY AND SUSTAINABILITY

RESOURCE DESCRIPTION

Children learn best when they make their learning visible and tangible. When we introduce children to the four R's of sustainability, we can encourage them to think about everyday tasks in different ways. We also need to help them think about everyday things in different ways as well. Tanzania is blessed with an abundance of sunlight. A question to ask children is how can the heat from the sun help us to do everyday tasks such as cooking?

COMPETENCE ADDRESSED

- Basic Science – energy and solar gain
- 4 R's of sustainability

OBJECTIVE(S)

- Understand the importance of good design
- Understand the value of reusing simple materials such as cardboard
- Importance of sanitation and nutrition (boiling water, cooking food)

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

1. Teacher can use this resource as a demonstration of the potential solar energy to enhance daily life
2. Teacher can use this resource for Science – heat, temperature, etc.
3. Teachers can use this resource for Design and Mathematics - form, function, measurement, shapes, etc.
4. Students can make this resource for their homes, linking school learning with everyday life

DETAILED STEPS

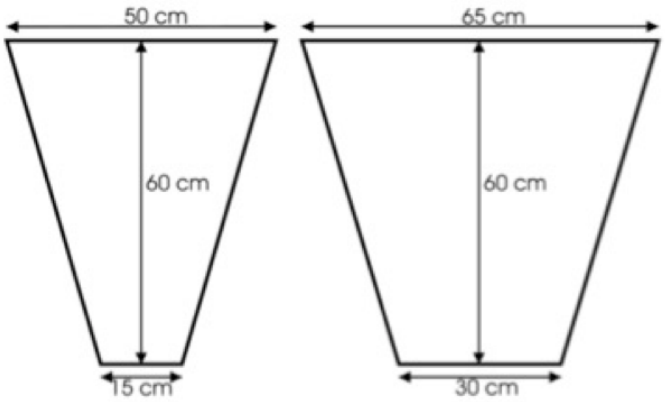
Thanks to the *Pembina Institute in Canada* for their solar oven design and directions that we have adapted for this project.

1. Introduce the basic concept of solar energy (heat). Explain to the students that dark surfaces absorb most of the visible light that falls upon them, and reflect very little. Visible light that is absorbed this way usually causes the dark-coloured surface to warm up. Of all colours, black is able to absorb the most light, and produce the most heat.
2. To produce enough heat to cook food, dark surfaces need a bit of design to improve their capacities. An easy way to do this is to use mirrors or other reflective surfaces. Aluminum foil can be used to gather the sunlight. Using good design, we can build a solar oven to create a cooking chamber. Heat is contained inside an insulated chamber and can be used to cook food.
3. Collect the necessary materials:

- Corrugated cardboard – sides from larger boxes are best
- Cardboard box with flaps (approximately 25 cm x 35 cm x 16 cm deep
- Duct tape
- Black paint
- White glue
- 500 ml plastic container
- Oven thermometer (if available)
- Aluminum foil 45.7 cm x 7.6 m roll (if possible – you can adjust sizes as needed)
- 1 large aluminum pan (approximately 15 cm x 30 cm x 8 cm deep)
- Shredded paper – scrap paper is fine as this will be used for insulation
- spoon
- utility knife
- measure stick or tape
- felt tip marker
- sunglasses
- paint brush
- cloth or protective gloves

Preparing the Reflective Panels

4. Using a meter stick or tape, draw 2 of each of the following shapes onto your cardboard.



5. Using your utility knife, cut out each of the 4 cardboard shapes.
6. Pour approximately 100 ml of the white glue into a disposal container (i.e., recycled plastic water bottle with the top cut off, etc.). Add 60 ml of water to dilute the glue. Carefully unroll enough aluminum foil to cover 1 cardboard section. Be careful not to fold or wrinkle the foil.
7. Use the paint brush to apply a thin layer of glue mixture onto 1 of your cardboard pieces. Be sure to spread the glue mix right out to the edges of the cardboard. You can use a scrap piece of cardboard to spread the glue evenly.

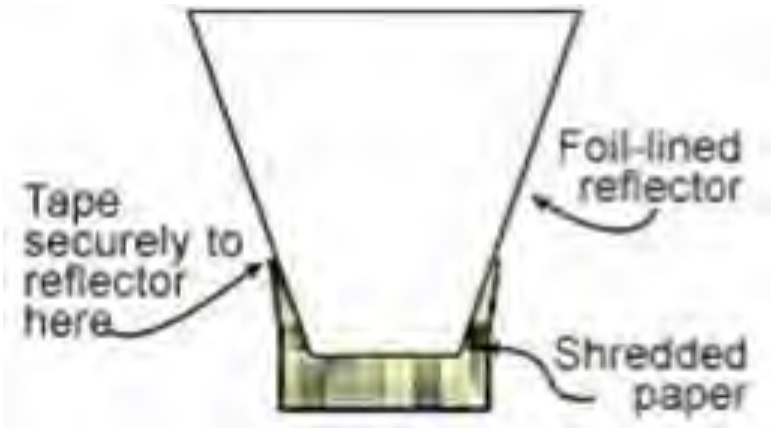
8. Before the glue dries, place a piece of foil on the cardboard. Make sure the shiny side of the foil is UP. Gently press any bubbles or creases out of the foil. If needed, you can glue smaller pieces of foil on the cardboard. Just make sure the shiny side is up. It's the shine that helps with the reflection and heat gain.
9. Using your utility knife, trim any extra foil from the edges of the cardboard.
10. Repeat steps 7 – 9 for the remaining sections of cardboard.
11. Rinse out your paint brush immediately so you can use it again. If you have glue remaining, cover it so it does not dry out. You will need it again later in this project.

Join the Panels

12. Cut 8 pieces of duct tape 60 cm long and set them aside (stick them to the edge of the table for easy retrieval).
13. Arrange the segments as shown in the photo below, foil side down, wide sections alternating with narrow ones. The narrow end of each should point toward you.
14. Carefully position the first two panels, keeping a 2 mm space between them. Position one of your 60 cm strips of duct tape over the joint between the panels. Press it onto the joint, being sure it sticks securely to both panels over its full length.
15. Join the third and fourth panels
16. Carefully flip the joined panels over on the table. This may require two people. Reinforce the joint between each panel using another strip of duct tape.
17. Stand your reflector up (foil side in), bringing the edges of the outer two panels together. Have your partner hold the reflector in position while you add the last piece of duct tape
18. Finish the last joint inside the reflector by applying the remaining piece of duct tape.

Adding the Insulated Box

19. Using duct tape, fasten the cardboard box securely to the bottom of the reflector using the box flaps. Be sure the box is centered. Add a few strips of duct tape to the corners to make the assembly more rigid.
20. Shred paper into thin strips. Stuff the shredded paper into the gaps between the box and the reflector.



Preparing the Baking Chamber

21. Mix your black paint with any leftover glue mixture from Step 11. If you don't have any glue left, add half the amount of glue and same amount of water to the quantity of paint you have.
22. Using your paint brush, paint your aluminum pan. You will probably need to apply 2 coats of your glue / paint / water mixture. Make sure you let it dry between coats. You know you have applied enough paint when you cannot see any aluminum on the inside of your pan.

Testing Your Oven

23. If you have an oven thermometer, place it in your painted pan. If you have clear plastic, you can cover your pan to retain additional heat. Place your pan tightly into the bottom of your reflector.
24. Take your assembled over outside. Position it so that it is fully illuminated by the sun. You want the Sun to shine directly onto the baking chamber with little or no reflection. We are lucky in East Africa because we are close to the Equator and the sun is typically directly overhead from 7:00 AM until 6:00 PM – with the peak heat at 1:30 PM. The Equator runs through Kenya to the north of us in Tanzania.
25. You can download a sun angle calculator from http://www.suncalc.org/#/49.495,11.073,5/2016.12.26/14:44/1
26. If the day is sunny and clear, the temperature in the oven should reach 100 degrees C in 20 minutes. If you leave it longer, the temperature could reach 200 degrees C which is an adequate temperature to cook many foods. Remember, 100 degrees C is the temperature water boils so you should be able to enjoy a cup of tea from your oven!

SUGGESTIONS FOR ASSESSMENT

Ask the students to

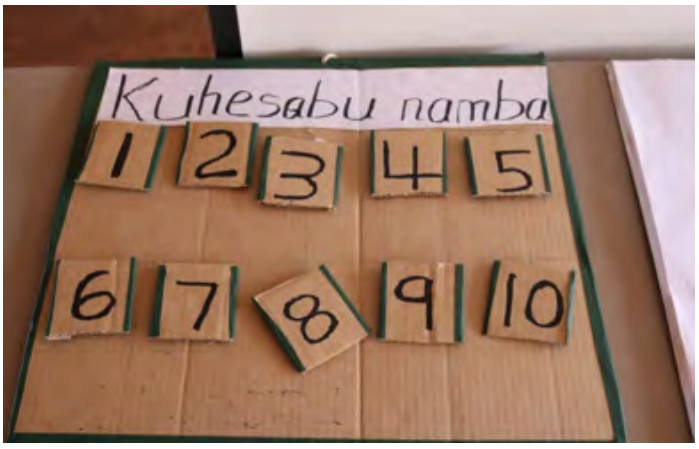
- Explain the parts of the oven and how each contributes to capturing solar heat
- Explain the purpose of painting the baking chamber black. What would happen if you had painted it a lighter colour?
- Consider ways of improving the solar oven
- Consider foods that could be cooked in the oven
- Chart the time and temperature gained with the oven
- Chart the time and temperature it takes to gain temperature at various parts of the day
- Chart how long the oven maintains its heat once the Sun goes down at the end of the day
- Consider how they might have to place the oven if they were living further north or south of the Equator. This might be an interesting question after the students have used the Globe resource suggested in Resource #3.

SAFETY TIPS

1. Use extreme caution when cutting cardboard with the utility knife. Extend the blade only as far as is needed to cut through the cardboard, and lock it into place.
2. Do your cutting on a cutting board or piece of scrap plywood, cardboard, or a kitchen cutting board. Use sunglasses when working with shiny materials in sunlight. Solar ovens can get very hot! Use cloth or gloves to prevent your hands from becoming burned.

Notes

Sample Resource 9.11 Number Board USING MAGNETIC STRIPS OR HOOK AND LOOP TAPE



RESOURCE DESCRIPTION

The Number Board is made from a magnetic strip or a hook and loop tape that is attached on a wooden or plywood board. Numbers are written on the tape and attached to pictures that show their values or numbers attached in a specific pattern. The tape is then attached on the board. The teacher then provides instruction on how to remove and attach the numbers. The tape should be thin enough especially for young children to enable them to attach and remove the numbers.

COMPETENCE ADDRESSED

- Number Identification
- Value of Numbers / Place Value
- Addition
- Subtraction
- Pattern identification
- Counting

OBJECTIVE(S)

- Identifying numbers
- Associating numbers and their value
- Adding numbers
- Subtracting numbers
- Identifying patterns in numbers
- Counting

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

- You can make a Number Board for as many groups as you have in your class. Make sure you include all the numbers you want students to interact with. If you are teaching place value make sure you align each number with its value. If you are teaching patterns skip spaces for students to fill in with appropriate numbers.

- You can suggest that groups create an additional/ subtraction problem for another group with whom they exchange the board to answer. You can also demonstrate how to use and create problems with a board to the whole class. Always make sure students have enough numbers from which to create a response.

DETAILED STEPS

1. First collect all the materials needed
2. Look for a board that has enough working space for groups in your class maybe 12 by 12 inches for a group of eight to ten students
3. Ensure the cutting is smoothly done – avoid sharp jagged edges
4. Cut strips of magnetic tape or hook and loop (about 2cm by 2cm)
5. Place each strip separately in a line – making sure they form a pattern or problem. In the case of value association top and bottom, have a number at the top and value label at the bottom
6. Write individual numbers and where necessary value labels on the strips of carton paper. One number or value label per strip.
7. Attach the strips on the numbers/ value labels in a manner that allows them to stick on the board
8. Attach numbers randomly on the board or have them to one side
9. Attach numbers randomly on the board or just have them to one available for students' use

SUGGESTIONS FOR ASSESSMENT

Ask the children to

- Identify the specific number from the pile
- Arrange the numbers from the biggest to the smallest
- Ask students to arrange the numbers from the biggest to the smallest
- Having put value labels ask students to associate numbers with the labels by sticking the appropriately
- Ask students to fill in the blanks from a series of numbers that for a pattern
- Let groups create number problems and exchange them for a response from other groups
- Have students write the patterns and value association tasks in their exercise books
- Have students create at least two or three ways of attaining the same answer to an addition problem by combining two and three numbers

SAFETY

Tools needed:

- Utility Knife
- Scissors
- Magnetic Strips or Hook and Loop Tape

Make sure your hand is well away from the board as you cut it. Keep the knife and scissors away from the reach of children.

Sample Resource 9.12
Sandals for Words and Numbers
RETHINKING USES OF CARTON AND MANILA PAPER

RESOURCE DESCRIPTION

Sandals are made from carton and manila paper. One outlines the shape of a foot on a carton and cuts it out. They then attach a manila paper on top of the carton cutting. The teacher then writes numbers that match each on one of the sandals. For example, one (1) on one sandal and zero (0) on another so the student can match the two sandals to make ten (10). The student may match the two sandals to other pairs of sandals with the same numbers or collaborate with other students to make a new pair.

COMPETENCE ADDRESSED

- Number recognition
- Matching numbers
- Addition
- Subtraction
- Assembling and arranging
- Recognizing Operations

OBJECTIVE(S)

- Recognizing numbers
- Associating numbers and their labels
- Adding numbers
- Subtracting numbers
- Assembling and arranging
- Recognizing operations

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

- You can make the sandals yourself or request students to each make their sandals. Make sure each sandal comes as a pair. Each activity is about matching the correct numbers written on sandals. For example putting together sandals that make the number 12 but matching sandals with number 1 and 2. As a teacher you may

choose to jumble up the sandals and let the students choose the correct sandals to make 12 either as a group or as individuals.

- You could also choose to put operational signs between two sandals e.g. addition or subtraction. For example, one and 2 with an addition operation between and expect a student to choose an answer which should be the sandal with number 3.

DETAILED STEPS

1. Collect used cartons and some manila paper
2. Get students to draw the outline of their foot or shoe so it has the shape of the foot
3. Use scissors to cut out the outline as accurately as possible
4. Also cut out two attached straps that are to be put as strappings of the sandal
5. Attach a fitting mala on the carton outline just so as to make it easy to write on attach the manila and the straps using glue
6. Write numbers on each sandal corresponding with activity you want students to do
7. Try and make sure each pair of sandals look similar and form a number that students can recognize

SUGGESTIONS FOR ASSESSMENT

Ask the children to

- Identify the specific number on each sandal
- Arrange the numbers on each pair of sandals from the biggest to the smallest
- Put operations between different such as addition and subtraction and ask students to find answers by putting sandals with correct number
- Ask students to fill in the blanks from a series of numbers on sandals that form a pattern

SAFETY TIPS

Tools Needed:

- Scissors
- Carton
- Manila Folders
- Pencil

Make sure your hand is well away from the board as you cut it. Keep the knife and scissors away from the reach of children.

Sample Resource 9.13
Water Pulley for Hand Washing
UNDERSTANDING A SINGLE FIXED PULLEY

RESOURCE DESCRIPTION

A single fixed pulley does not increase the force we apply it merely changes the direction of the force which will be convenient for children to raise the level of water in a jar by exerting downward pull using a foot.

COMPETENCE ADDRESSED

- Change, constancy, and measurement
- Motions and forces
- Abilities of technological design
- Measurement length, weight and effort

OBJECTIVE(S)

- Understand the purpose of simple machines
- Components of a pulley
- Balance and unbalanced forces
- Pulling and pushing forces
- Science behind simple machines, namely the single fixed pulley
- Making work easier
- Mathematics, specifically length and weight

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

1. Introduce the concept of a simple machines
2. Application of force and resistance
3. Observe how a fixed pulley works-flag post
4. Discuss relationship between force applied, weight and load lifted
5. Draw and label parts of a fixed pulley
6. Organize students in groups. Allocate materials to create a single fixed pulley
7. Let students discuss application of pulleys in real life situations i.e. cranes

DETAILED STEPS

1. You require a 4 meters long piece of wood (5 cm by 5cm thick)
2. Cut it 3 pieces. 2 pieces 1.5 m long and 1 piece that is 1m long
3. Attached the 1m long piece on the two 1.5m long using nails horizontally
4. Make a 2 cm groove at the center of the 1m long amounted wood
5. Tie a 5-litre jerry can on a 1.2m long sisal string and other end tie 50 cm long sick
6. Amount the string on the groove
7. Put some water on the 5 litres can
8. Step on the 50cm long stick
9. Lift the jerry can
10. Support the vertical stands with tins full of soil
11. Observe the push and pull movement using different amount of water

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe the students as they work within their groups assemble the simple fixed pulley
- Note the way they critically think, problem solve, observe safety
- Note the collaboration and their capacity for trial and error
- Facilitate and support as they work together
- Data collection skill as the proceed with trials

Formative Assessment

- Using a pre-determined checklist of competencies, observe the students growing skills and abilities.
- Share with the students their grades against the checklist criteria and offer suggestions for improvement and growth

Summative Assessment

- Whether the students recognize that pulleys are simple machines used to decrease the amount of effort required to move a load, by changing the direction of force applied to the load.
- Whether students understand that more pulleys means more advantage.
- Whether students understand that technological advances occur based in the needs of society.
- Whether they understand the design process and can use it to build a
- The student work collaboratively, all team members should be free to reach, explain, and justify their own individual conclusions.
- The student knows that to compare and contrast observations and results is an essential skill in science.
- Students analyze and communicate results

TOOLS

- Sisal string or Rope
- Nails
- Saw
- Hammer
- Chisel
- 5 liters Jerri can
- Tins with soil for support

Sample Resources 9.14 Trundle Wheel SIMPLIFIED SURVEYOR'S TOOL

RESOURCE DESCRIPTION

Trundle wheel is a measuring gadget, a streamlined type of a surveyor's wheel. It is generally utilized by individuals who require a simple way to measure one place to another. The trundle wheel is a wheel with a handle joined to the hub permitting the trundle wheel to be held effortlessly, and a clicking gadget which is activated once per complete turn.

A measuring wheel is great when measuring things that are longer than a tape measure, yardstick or meter stick. Also for things that aren't straight! A Measuring Wheel encourages students to use addition, multiplication, and other math skills while having fun, indoors or outdoors.

COMPETENCE ADDRESSED

- Circumference of a circle
- Shapes and parts of a circle
- Measurement
- Addition and multiplication of numbers
- Simple machines (second class levers), screw, wheel and axle
- Friction and force

OBJECTIVE(S)

- Understanding measurement
- Understanding parts of a circle
- Understand different units of measurement
- Wheel and axle
- Measurement and perimeter of a circle
- Simple second class lever

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

- Introduce the concept of measurement
- Discuss different forms of measurement
- Talk about different units of measurement with a focus on length
- Discuss both standard and nonstandard units of measuring length

- Talk about different tools of measuring length
- Introduce the concept of measuring distance using a trundle wheel
- Discuss the advantages and disadvantages of using a trundle wheel
- Deliberate on a trundle wheel a simple machine-2 class lever

DETAILED STEPS

1. Decide if you want to make an inch or cm. measuring wheel.
2. Use a tape measure to measure the outside edge of your wheel (the circumference).
3. Make a large arrow on the wheel (plate) to indicate the starting point.
4. Mark off the plate in inches or centimeters, if desired.
5. Make a small hole in the center of the plate.
6. Attach the handle with a large paper fastened
7. Now you have a great math and science tool
8. Next choose something that you want to measure!
9. PIace the arrow on the plate at your starting point.
10. Use the arrow on the plate to count the number of times the plate turns.
11. Attach a small object on the arrow that will make audible click
12. When done measuring, multiply the number of times the plate turned by the circumference.
13. Addition can be used instead of multiplication if desired.
14. Students can convert their measurement from cm. or inches to meters or yards

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe the students as they work and note the way they critically think, problem solve, observe safety
- Note the collaboration and their capacity for trial and error
- Look at their estimation and unit conversion skills
- Observe their measuring skills

Formative Assessment

- Using a pre-determined checklist of competencies, observe the students growing skills and abilities
- Share with the students their grades against the checklist criteria and offer suggestions for improvement and growth

Summative Assessment

- Test the students on their understanding of different units of measurement
- Test students' ability to convert units of measurement
- Check students' ability to estimate and measure

TOOLS

Heavy duty plastic plate or other round object, wood
Tape measure
Marker
Large fastener
One meter stick with a hole at one end
Screw
Saw

Sample Resource 9.15
Building a Vinegar/Acidic Fruit Juice Battery
GENERATING ELECTRICITY

RESOURCE DESCRIPTION

A vinegar battery consists of vinegar or lemon juice solution, a copper wire, iron nails dipped sections of the ice plate containing the vinegar/lemon juice solution. All the nails should be of the same size and the copper wires should be slightly longer to facilitate more compact coils. Lastly a light bulb is required to demonstrate the flow of electrons and conversion to electricity.

COMPETENCE ADDRESSED

- Electricity and flow of electrons
- Positive and negative Electrodes and electrolyte
- Circuit and current flow
- Battery and energy conservation.

OBJECTIVE(S)

- Understanding basics of electricity
- Understanding how positive and negative electrodes connect in current flow
- Understanding of importance of creating and conserving clean energy

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

1. Introduce the concept of electricity
2. Introduce related concepts in electricity
3. Discuss how the tool is able to allow electric flow and evidences
4. Discuss the role of locally available electrolyte and how to improve them
5. Importance of safety in making and handling the battery and electricity in general
6. Let students other share ways that electricity is generated
7. Organize students in groups and allocate materials required to create the battery

DETAILED STEPS

1. Gather the resources the students will need in developing the battery
2. To develop the battery one requires: vinegar/dilute lemon juice, 5 pieces of copper wire, iron nails, goggles, light bulb, ice plate or old egg tray, an ammeter and old plastic bottles
3. Wrap the copper wire on the nails
4. Fill the 6 cells with the electrolyte
5. Insert the nails on the cells and they should never touch or contact one other
6. Place the small light bulb between the sections with copper wire and the nail
7. Remember that vinegar acts as the electrolyte
8. Electricity is generated by reaction of two different metals (electrodes) and the electrolyte
9. Use an ammeter to show the amount and direction of the current.
10. Allow students to test with different concentrations of the electrolyte and record the observation

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe the students as they work within their groups to make the battery. Note the way they critically think, problem solve, observe safety
- Note the collaboration and their capacity for trial and error
- Facilitate and support as they work together
- Data collection skill as the proceed with trials

Formative Assessment

- Using a pre-determined checklist of competencies, observe the students growing skills and abilities.
- Share with the students their grades against the checklist criteria and offer suggestions for improvement and growth

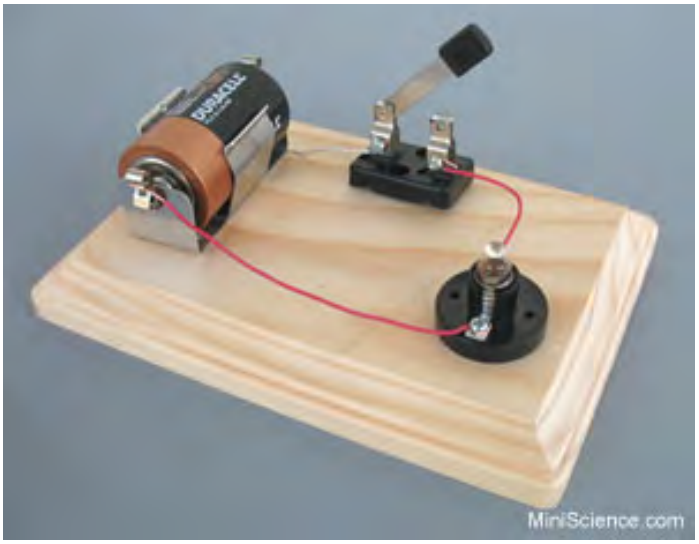
Summative Assessment

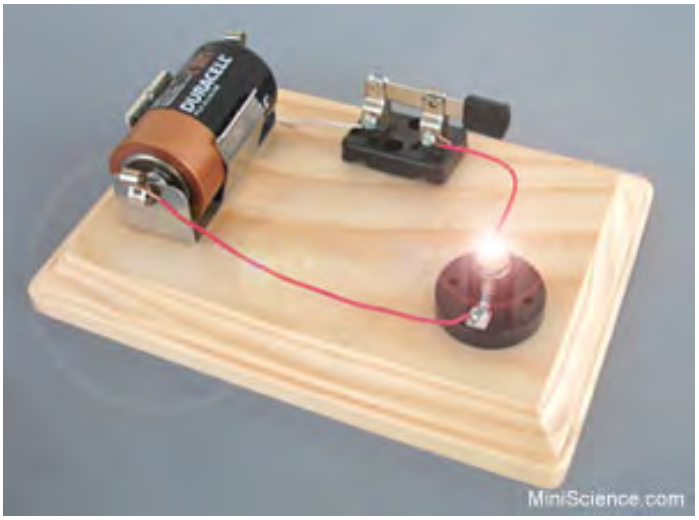
- Test the students on their understanding of different electricity concepts and related concepts through an experiment (individual task)
- Significant of clean energy and conservation for environmental care

TOOLS

- Red/white vinegar
- Lemon
- 5 pieces of thin copper wire measuring 8cm each
- 5 - two inch nails
- Old egg tray/ice plate
- Goggles
- Tongs/pliers
- Lighting bulb
- Gloves

Sample Resource 9.16 Simple Circuit
BASIC ELECTRONICS





RESOURCE DESCRIPTION

Simple electric circuit brings out the basic concepts of electricity and electrical circuits by developing a light circuit powered by a battery and controlled by a switch. It also brings out enduring understanding of what is an electric current and how it flows through good conductors of electricity.
In addition, it creates a better understanding of how electrical conductors help in the flow of electric current and insulators insulate the respectively.

COMPETENCE ADDRESSED

- Electricity and current flow
- Essential parts of a simple circuit
- Conductor and nonconductors of electric energy
- Electric resistance and charges
- Use of dry cell batteries with chemicals

OBJECTIVE(S)

- Understanding basics of electricity
- Components of a circuits and types of circuits
- Types of cells
- Understanding of importance conductors, insulators, charges and insulators

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

- Introduce the concept of a simple circuit
- Introduce related concepts in a simple circuit
- Discuss how current flows in a circuit
- Discuss electrical resistance and short circuits
- Importance of safety assembling and handling a simple circuit
- Forms of battery and bulb arrangements
- Draw and label parts of different circuits
- Organize students in groups and allocate materials required to create a simple circuit
- Let students discuss application of circuits in real life situations

DETAILED STEPS

1. Use the picture bellow to see how you must mount the components on the board. Use small mounting screws to mount the battery holder, the switch and the lamp holder to the appropriate places on the board. A screw driver and assistance of an expert adult may be required.
2. Loosen the contact screws (not mounting screws) on the lamp holder and on the switch to make them ready for connecting the wires.
3. Cut 3 pieces of wire (any color) to 20cm, 15cm and 12cm.
4. Remove the insulation from 1/2 inch of each end of the wires. To do that first makes a cut on the plastic insulation all around the wire. Then pull the insulation out.
5. Use the 20 cm long wire to connect the battery holder to the one of the contact screws on the lamp holder.
6. Use the 15cm long wire to connect the remaining contact screw of the lamp holder to one of the screws on the switch
7. Use the 12cm long wire to connect the remaining screw on the switch to the remaining clip of the battery holder.
8. Insert the battery, screw a light bulb into the lamp holder and close the switch. The light bulb must light up. If it does not check all the contacts and try again. You may also need to check the battery and the light bulb

Warning: No electrical contact will be made if you have not removed the insulation from the ends of the wire. Do not use flame to remove the insulation. Doing this is dangerous and will blacken the ends of the wire. In addition, it produces a poisonous gas.

Adult supervision is required!

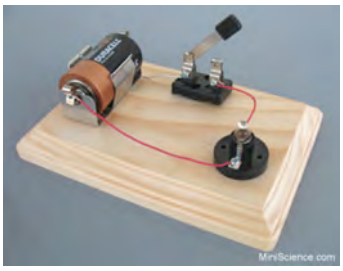


Figure 1: When the switch is open there is no light

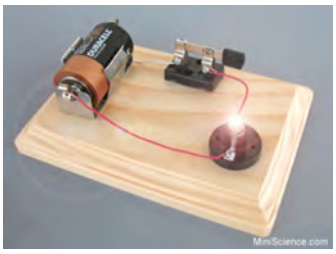


Figure 2: When the switch is closed the circuit is complete and the bulb lights up.

Reference: http://www.miniscience.com/

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe the students as they work within their groups assemble the simple circuit
- Note the way they critically think, problem solve, observe safety
- Note the collaboration and their capacity for trial and error
- Facilitate and support as they work together
- Data collection skill as the proceed with trials

Formative Assessment

- Using a pre-determined checklist of competencies, observe the students growing skills and abilities.
- Share with the students their grades against the checklist criteria and offer suggestions for improvement and growth

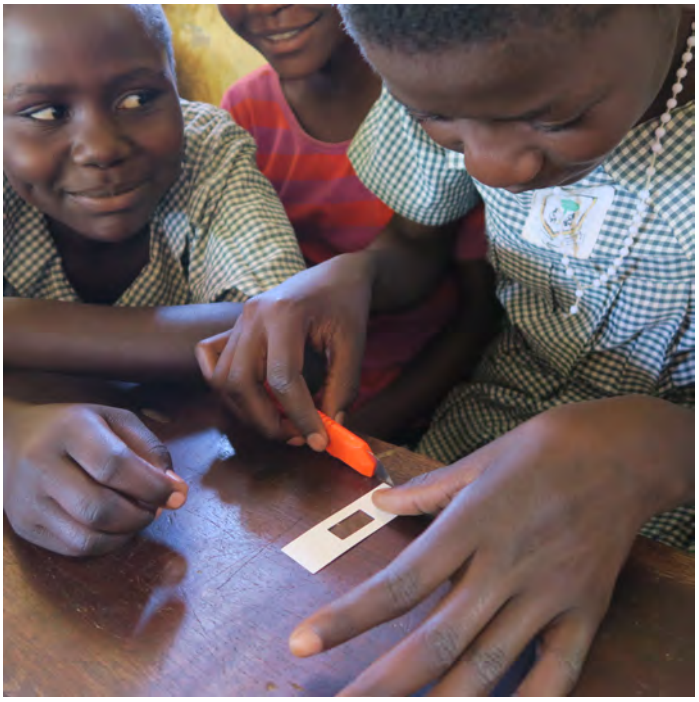
Summative Assessment

- Test the students on their understanding of different electricity concepts and related concepts through an experiment (individual task)
- Does electricity change in forms of energy
- Significant of clean energy and conservation for environmental care.

TOOLS

- Wooden base to mount the circuit
- 2 Light Bulbs (1.2 Volt)
- 1 lamp holder
- 1 Battery holder (for D size battery)
- 1 Simple Switch (Known as knife switch)
- Screws used to mount the switch and the lamp holder
- Insulated solid copper wire (Gage 22)
- Pliers and industrial gloves

Notes



Sample Resource 9.17 Foldscope
A FOLDABLE MICROSCOPE FOR FIELD WORK

RESOURCE DESCRIPTION

A Foldscope is a small microscope that is assembled using origami techniques. It allows users to explore items too small to see with the human eye alone. It was developed by Manu Prakash at Stanford University as an inexpensive tool to help students, Citizen Scientists, and community health workers explore the world of microscopy and conduct basic identification and discovery. The Foldscope is made using punched cardstock paper and a small spherical lens. This small microscope has the capability of magnifying certain objects from 140X to 2 micron resolution depending on the spherical lens that is used.

The Foldscope has an additional magnetic attachment which allows users to connect the Foldscope to the camera commonly found in most smart phones. The attachment allows users to take pictures of specimens, send those images to other users, and project images on a screen or wall so larger groups can see.

COMPETENCE ADDRESSED

- Critical thinking – Encouraging users to ask their own questions about the world around them and question their assumptions about how small organisms interact with larger organisms.
- Creative thinking – Exploring the local environment by creating slides of different local plants and animals. Extension: use field testing to solve a local problem involving infection/disease/water quality.
- Microscopy – Understanding the different parts of the cell, cellular reproduction, and how small organisms can impact human and livestock health.
- Spatial Literacy – Exploring different length scales of life.
- Scientific Literacy –Understanding independent

and dependent variables, and learning to ask questions, test predictions, and making new meaning

OBJECTIVE(S)

- Understanding the different parts of a microscope and how they work
- Understanding the magnification power of a microscope
- Understanding the properties of light (refraction, transparent, translucent, and opaque)
- Understanding different parts of specimens (cells, insect parts, leaves, etc.)
- Understanding optics: spherical lens refraction, focal point, observer, image, object, focal length
- Understanding the use of appropriate technologies to aid in field research
- Fostering a scientific mindset – beginning to think like a scientist

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

For basic 140X magnification power:

- Organize students into small groups (4-6 is perfect) and have them create a slide of a local specimen (i.e., mosquito, insect wings, insect legs, other insect parts, human hair, purple onion skin, different types of local leaves). Check with your curriculum as some specimens are part of your core Science learning competencies.

- Teach students the proper way to create a slide. Note: The Foldscope comes with paper slides (6 in total), and slides can be made by using standard sticky tape found in most stores. The Foldscope is also designed to accommodate standard sized microscope slides found in any lab.

- Students should view their slides using the Foldscope. In their notebooks, they should sketch what they have seen and they should try to label the parts. Ask the students to compare their drawings. Ask your students to refer back to the slide to determine what details might be missing from their drawings. Students can redraw their sketches on the blackboard so you and the class can discuss the drawing and the science aspects of the specimen.

- If you have a smart phone with a camera, use the Foldscope and camera attachment magnet. Using the camera function on your phone, project the contents of the slide onto the wall of your classroom. Discuss, as a class, why some slides show much better detail then others (leaves need to be cut very thin to see them – link to transparent, translucent, opaque). Compare the projection of the specimen to the student drawings. Allow the students to redraw their sketches, if necessary.

13. Use the sharing of the student drawings to launch a discussion on independent and dependent variables and how they impact what you can see. For example, ask the question what variables are involved in this experiment (i.e., thickness of leaf, amount of light, different kinds of leaves, color of leaves, care in preparing the slide, etc.).

14. Use the understanding of independent and dependent variables (#2) to ask: Why a specimen's image becomes fuzzy or clear at different times. What is the variable that is being changed? What kind of variable is this?

- Build on the discussion and ask what would happen if you vary the distance from the lens to the object .

This question will help launch a discussion and instruction on what the focal length, focal point, image, object, light rays, refraction, and magnification power in order to build an understanding of optics.

- Using an onion skin as a specimen, ask the students to identify the parts of the cell, and discuss cellular reproduction and the difference between animal cells and plant cell.

- Explore wing scales and structure vs pigment, introduce different wavelengths of visible light, the properties of a wave (https://microcosmos.foldscope.com/?p=8965)

DETAILED STEPS

1. Purchase foldscopes from https://www.foldscope.com
2. Foldscope assembly directions - https://www.protocols.io/view/Foldscope-Assembly-Instructions-fjwbkpe
3. Explore foldscope videos from https://www.foldscope.com/faq/
4. How to project onto paper using the foldscope and a simple LED light https://microcosmos.foldscope.com/?p=17097

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe students as they work in groups to assemble their slides
- Observe students as they work in groups to use the foldscopes
- Note the ways in which they engage in critically and creative thinking
- Facilitate and support the group work by asking increasingly challenging questions
- Observe the students' data collection, drawings and observations as they use their foldscopes

Formative Assessment

- Use a pre-determine checklist of competencies based on your specific curriculum and observe the students growing skills, abilities, and dispositions / mindsets
- Share with students your checklist of competencies and discuss areas for their growth and development

Summative Assessment

- Test the students understanding of the learning objectives
- Test the students using your formative criteria or a rubric to determine competencies

SAFETY TIPS

NEVER use the foldscope to look directly at the sun. Looking directly at the sun through the foldscope lens could cause blindness.

ACKNOWLEDGEMENTS

- Manu Prakash and the research team at Stanford University
- Rose from the Arua Core Primary School Teachers' College
- Connor Pilling – 2017 Student - UBC Bachelor of Education
- Cindy Bourne – UBC Faculty of Education, Instructor

Notes

Sample Resource 9.18 Fun with Flight
UNDERSTANDING THE FOUR FORCES OF FLIGHT

RESOURCE DESCRIPTION

Historically, humans have been fascinated by flight, watching the birds soar above us and wondering how we might join them. Birds and insects make flight look easy, but through experimentation, problem finding, and good design we have come to understand that four primary forces must be tamed in order for us to fly. Those forces are lift, gravity, thrust, and drag. Aeronautical engineers must work within the constraints and affordances produced by those four forces when they design and prototype even the simplest of airplanes.

This Fun with Flight resource will introduce students to the four forces and explain the scientific principles that underpin them. This resource will also invite students to design their own planes and attempt to determine the essential design components needed to fly them.

COMPETENCE ADDRESSED

- Critical thinking – Encouraging students to ask their own questions about the world around them and question their assumptions about how lift, gravity, thrust and drag impact flight
- Creative thinking – Exploring innovations and engineering principles that influence in the aesthetics and elegance of simple aeronautic design. Extension: Draw on field testing to refine plane designs
- Spatial Literacy – Exploring different sizes, shapes, weights and materials
- Scientific Literacy – Understanding the scientific and engineering principles that impact flight and airplane design

OBJECTIVE(S)

- Understanding the forces impacting flight
- Understanding the engineering required to design efficient airplanes

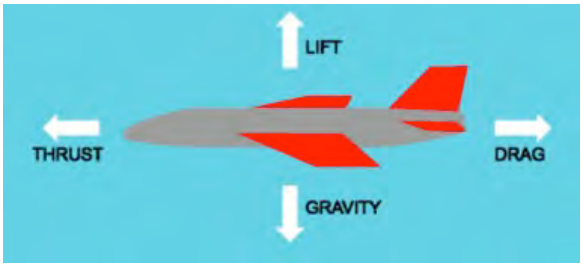
- Understanding the role of testing in product design
- Understanding the use of appropriate technologies to aid in field research
- Fostering an aerospace engineering mindset – beginning to integrate the concepts of mathematics and physics

SUGGESTIONS FOR USING THE RESOURCE IN THE CLASSROOM

1. Group students and have them make a Model Plane, using the Sample Plane included in this resource. Students need the carefully cut out the pieces of the Sample Plane and glue the parts either cardboard or a recycle file folder. Extension: Have different types of sturdy paper available to different groups and notice if the weight of the paper impacts the flight potential of the Sample Planes.

2. Once assembled, have the students fly their planes and make field notes a they observe the flight paths and successes of their own planes and the others of their classmates.

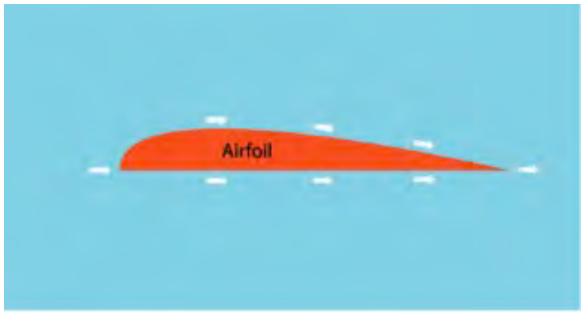
3. Introduce the four forces that impact flight - lift, gravity, thrust, and drag.



4. *Lift* is the force that keeps the airplane in the air. Without lift the plane would not fly. Lift can be a very complicated force to explain, but here are two basic principles that need to be understood.

BERNOULLI'S PRINCIPLE (NAMED AFTER SWISS PHYSICIST DANIEL BERNOULLI)

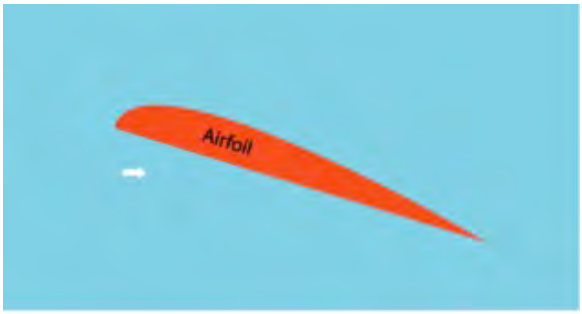
When you look at the wings of an airplane from the side, you will see they are not flat. The wing has a curved shape to it. This shape is called an airfoil. Airfoils are specially designed to produce lift.



To understand how Bernoulli's principle causes lift, we must first understand that air usually presses equally on all sides of an object. Suppose that as the plane flies forward, the approaching air splits up when it hits the leading (front) edge of the wing and rejoins at the trailing (back) edge of the wing. The airfoil shape causes the air to go farther over the top of the wing than under the bottom, both in the same amount if time. This means the air on top of the wing must move faster. When air speeds up, its pressure gets lower. Since the air pressure on top of the wing is lower than the air pressure on the bottom of the wing, the wing produces lift! This phenomenon is called Bernoulli's principle.

NEWTON'S LAW OF MOTION (NAMED AFTER SIR ISAAC NEWTON)

Newton's third law of motion states, "For every action, there is an equal and opposite reaction." Newtonian lift largely depends on the tilt of the wing or "angle of attack". If the leading edge of the wing is pointing upward, the bottom surface is deflecting oncoming air downward. When this air bounces off the bottom surface of the wing (action), it



pushes the wing upward (reaction)...or produces lift.

5. ***Gravity*** is a force that we are all familiar with. It's what causes any object you throw into the air to come back to the ground. Gravity is also what keeps us on the ground. Without gravity, we would all float away into space! With airplanes, gravity works against lift by pulling the airplane toward the ground.

6. ***Thrust*** is the force that causes the plane to move forward through the air. In a real airplane, this is produced by the turning propellers or jet engine. With a paper airplane, the thrust is produced when you throw the plane into the air. Without thrust, planes could not produce lift.

7. ***Drag*** is the force that tries to slow the airplane down. Drag is produced when air flowing over the plane causes friction. When the plane is flying, it must push oncoming air out of the way. As this air is pushed around the plane, it bumps into other air molecules. Air close to the surface of the airplane also wants to try to stick to it. All of this causes friction. Have you ever ridden your bike on a windy day? The wind hitting you in the face that makes it hard to keep moving is drag.

8. Lift and thrust help to keep a plane flying. Gravity and drag work against it. We can't do anything to change gravity, but we can try to minimize drag and increase lift and thrust. This will make an airplane fly well.

9. Within their groups, ask the students to demonstrate how the four forces (lift, gravity, thrust, and drag) impact their planes.

10. Ask the students fly their planes again and use their growing understanding of the four forces to explain what they are observing in their experiential flights.

11. Allow the students to experiment with several basic airplane designs. You might create a wall poster of the steps for each plane so students can experiment on their own.

DETAILED STEPS

- Follow the steps for each of the sample airplane. Students will need a piece of A4 paper for each of the airplanes. The airplane samples can be found at the end of this resource or online at http://www.funpaperairplanes.com/plane_downloads.html.

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe students as they work in groups to assemble their planes
- Observe students as they work in groups to experiment with their planes
- Note the ways in which they engage in critically and creative thinking
- Facilitate and support the group work by asking increasingly challenging questions, using the language of the four forces that impact flight
- Observe the students' data collection, drawings and observations as they use their planes and observe the flight of other students' planes

Formative Assessment

- Use a pre-determine checklist of competencies based on your specific curriculum and observe the students growing skills, abilities, and dispositions / mindsets
- Share with students your checklist of competencies and discuss areas for their growth and development

Summative Assessment

- Test the students' understanding of the learning objectives
- Test the students using your formative criteria or a rubric to determine competencies

SAFETY TIPS

Make sure you keep the paper planes out of the blades of fans and other electrical equipment. Also, remind students to NOT fly their planes at other students as the planes could injure students.

ACKNOWLEDGEMENTS

http://www.funpaperairplanes.com

Sample Resource 9.18 Fun with Flight

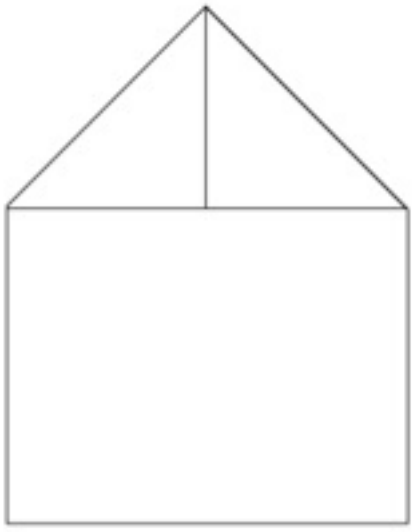
FUN WITH FLIGHT

HANDOUT #1: BASIC PAPER AIRPLANE

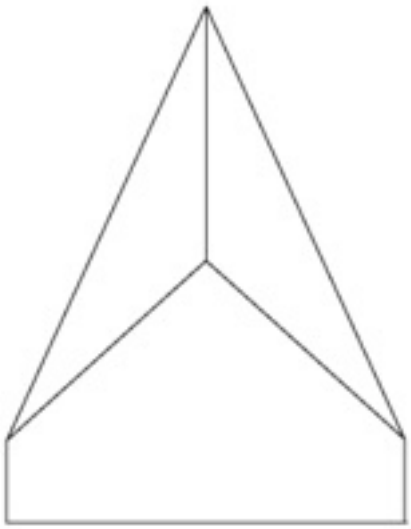
Each student group will need a copy of the Sample Plane parts and a piece of sturdy paper (i.e., old file folders, cardboard, poster board, etc.).

1. Orient your piece of paper vertically on your table.

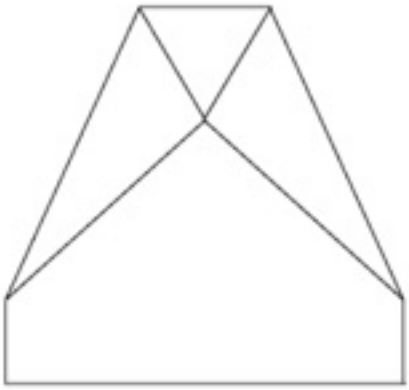
2. Fold the top left and right hand corners to the center of the page.



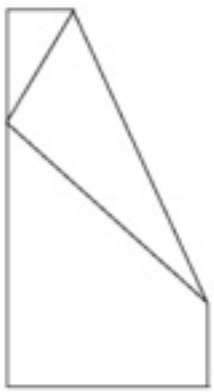
3. Again, fold the top left and right hand corners to the center of the page.



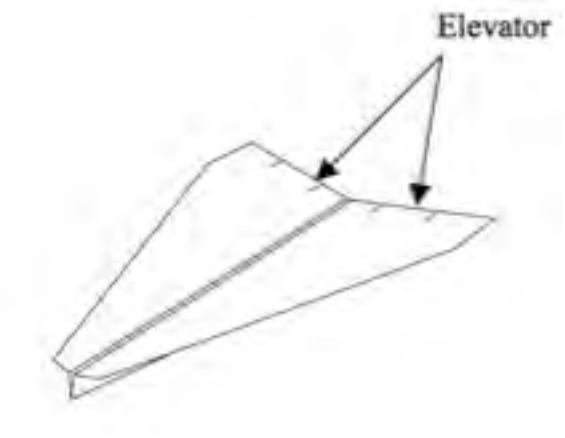
4. Fold the tip of the paper downward.



5. Flip the paper over. Fold the left side over onto the right side and crease sharply.



6. Fold the wings down and partially open the folds you just created so the wings stick out straight.



7. Cut 2 slits, 2.5 centimeters apart, along the back edge of each wing. These cuts will allow for ***elevator adjustments.***

Elevators are flight control surfaces, usually at the rear of an aircraft, which control the aircraft's pitch, and therefore the angel of attack and the lift of the wing. The elevators are usually hinged to the tail of the plane. They stabilize the plane allowing it to create less air currents.

8. You can also add ***wing dihedral*** by gently rolling the wings up slightly, away from the plane's fuselage (body).

Wing dihedral is the upward angel visible on all aircraft wings. ***Dihedral*** makes planes more laterally stable. When planes aren't stable, pilots spend time adjusting the angel of their wings in reaction to wind currents and the thrusts and drags those currents create.

For example, when a pilot banks an airplane (turning to one side), the lift vector tilts in the same direction as the bank. And when that happens, the airplane starts slipping in the same direction, in this case, to the right. The problem is, if the pilot had a straight-wing aircraft, there is no force that will bring the airplane back to wings-level flight with out the pilot dramatically having to intervene.

Notes

Sample Resources 9.19 Hand Puppets ENCOURAGING STORYTELLING AND FOSTERING LITERACY

RESOURCE DESCRIPTION

Hand puppets can be used with children as an active way to engage them with the characters in a story. Hand puppets are fun and are an easy way to support storytelling with a large group of children. They are also easy to make and share with children.

Hand puppets allow the storyteller to expand beyond an existing story and ask the children what a character might do next or what else the character might do. Hand puppets support imaginative play amongst the children, and they can be used by the children to create additional stories or other plot scenarios and story endings.

Educators suggest that hand puppets can help to

1. Stimulate children's imagination
2. Support emotional development
3. Improve motor skills
4. Learn etiquette through taking turns and active listening
5. Boost confidence in speaking and asking questions

COMPETENCE ADRESSED

- Critical thinking – Encouraging students to ask their own questions about the characters, exploring how the characters might act in different roles or situations

- Creative thinking – Encouraging other stories with existing puppets and creating new puppets and develop their imaginations

- Spatial Literacy – Encouraging the development of small motor skills required for students to make their own puppets

OBJECTIVES

- Develop speaking and listening skills.
- Encourage communication, knowing that children of communicate more easily with puppets, which gives them confidence to express their ideas and feelings
- Develop skills in shy children or children who have experienced trauma to become acquainted with others and gain empathy through the roles they take on using puppets as "their voice"
- Develop skills in children to try on new personalities and take them off again, recognizing that with a puppet on their hand, they can broadening their own in the process.
- Help to develop resilience in children recognizing that scary animal hand puppets like lions and snakes or shy ones such as a tortoise or small birds can help children master uncomfortable feelings
- Develop skills in shy children or children who have experienced trauma to develop resilience and trust through opportunities to gain some control over their world by working out fears and frustrations using a puppet

SUGGESTIONS FOR USING ADULT MADE HAND PUPPETS IN THE CLASSROOM

Directions for making two types of hand puppets are included in the section entitled ***Detailed Steps***. The directions are written for adults (i.e., teachers, parents, local crafts people, etc.). However, children, depending on their age, motor skills and access to materials, can easily make hand puppets, using found materials such as paper, fabric, toilet paper rolls, socks, etc.

The following ideas are offered to help you consider ways you might use hand puppets in your work with children

1. Hand puppets can be used to support the telling of an existing written story or to help illustrate the characters in an oral story. The storyteller can use the puppets to actually tell the story or use the puppets to act out portions of a story.
2. The storyteller can assign a puppet to a member of the audience and ask that person to help the storyteller to tell the story.
3. When using puppets to support language development:
    a. Make sure the puppets are telling a good, clear story that has 2 or 3 characters and a simple, easy to follow plot
    b. Try to have the puppets repeat lines or rhymes to encourage student interaction, engagement, and anticipation
    c. Encourage the students to use the puppets themselves to foster their imaginations and language skills
4. When using puppets to support social / behavioural development:
    a. Use the puppets to talk / demonstrate a range of emotions such as pain, fear, joy, aggression, frustration, shame, anxiety, and problems such as illness or death. Be sensitive to the prior experiences of the children in your class as the discussion of these emotions can trigger reactions
    b. Recognize that sometimes children who are timid, shy, non-assertive, or victims of trauma can use puppets to express and work through emotions or problems that are difficult for them to talk about or deal with directly. These situations need care and caution and storytellers must be ready to offer support and care if the puppets help the children to discuss or disclose emotional topics
5. When using puppets to support conflict resolution:
    a. Use the puppets to support role play and talk about ways in which the puppets can gain empathy,

deal with aggression and refrain from bullying

6. When using puppets to foster thinking skills:
    a. Ask the children to retell stories to foster their cognitive skills of recall, attention to detail, vocabulary development
    b. Ask children to develop their own stories to foster their imagination and creativity
    c. Ask children to tell stories together, sharing puppets to foster imagination, creativity and collaboration
7. When using puppets to develop motor skills:
    a. Introduce hand gestures, finger movement to develop fine motor skills when manipulating the puppets
    b. If you are using a small stage (see ***Using Hand Puppets to Encourage Storytelling and Literacy – Part 2***), for the children develop their spatial senses by moving their puppets within the stage space and manipulating the puppets to tell the story

DETAILED STEPS – MAKING A SOCK PUPPET

MATERIALS NEEDED FOR SOCK PUPPET:

- Clean sock – can be used, doesn't need to be brand new
- Buttons
- Discarded fabric
- Thread
- Needle
- Scissors
- Ink pen

DIRECTIONS

1. Place your hand directly into the sock, allowing your fingers to go all the way to where your toes would go. Your four fingers form the top of the puppet's mouth and your thumb forms the bottom of the puppet's mouth. By moving your thumb and fingers up and down, your puppet can talk.
2. Using your ink pen, make two marks on your sock, approximately where your knuckles are. These marks are were you will sew your buttons to form the puppet's eyes.
3. Using your ink pen, make another mark between the end of the sock and the eye marks. This 3rd mark will be where you can sew on a nose.
4. Take your hand out of the sock and sew on your 2 buttons to form the eyes.
5. If you have addition buttons, you can use a button to make the nose. Otherwise, you can make a nose by rolling up scrap fabric and sewing it onto the puppet.

6. Using your scrap fabric, you can sew on ears, make clothing, and otherwise decorate your puppet.
7. The puppet shown in the illustration has a mouth sewn into the space created by your thumb and fingers – you can add a tongue as well, depending on your sewing abilities.
8. Think about all the creative additions you can make. The children will love the details you add, but there is nothing wrong with just a simple puppet to get you started! Details you might sew onto your sock puppet include
    a. Tail
    b. Forked snake tongue
    c. Horns
    d. Ears
    e. Whiskers
    f. Etc.

DETAILED STEPS – MAKING A SMALL PUPPETS USING PAPER ROLLS

MATERIALS NEEDED SMALL PUPPETS USING PAPER ROLLS:

- Paper rolls or cardboard or used file folders that can be rolled
- Discarded fabric
- Scissors
- Glue
- Ink pen

DIRECTIONS

1. Using either a discarded toilet paper roll or a rolled piece of cardboard, begin to shape your puppets. Most toilet paper rolls are approximately 11 cm in height. If you are making your own cardboard rolls, cut yours 11 cm so the following directions will be accurate.
2. Measure 2 cm down from the top of the roll and cut this off to create the arms and hands of your puppet.

3. Shape your arms and hands.

4. Using your pen, divide your paper roll into approximate thirds 1/3s. The top third can be decorated as the head and face, with appropriate head coverings or other details.

5. The bottom 2/3 are for the body – you can wrap the entire bottom third to create a dress or you can cut a v shape into the bottom third to create legs.

6. You can choose to cover your puppet arms with fabric or leave your puppet arms bare.
7. Attach your puppet arms approximately at the 2/3s mark. You can use glue or a stapler is needed.

8. Dress your puppets using scrap fabric. You can cut Glue the fabric directly to the cardboard.
9. Draw on facial features (eyes, nose, hair, beard, etc.) directly onto the cardboard.
10. You can also cut cardboard tools or items to put in their hands, depending on the story you are telling. Have fun accessorizing your puppets!

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe students as they tell stories using the puppets
- Observe students as they listen to the puppets and ask questions to see if the children can follow the story plot and action
- Note the ways in which the children engage in critically and creative thinking
- Observe the students as they use the puppets to tell their own stories – is there a logic plot; good character development; a clear beginning, middle and ending to the story?

Formative Assessment

- Use a pre-determine checklist of competencies based on your specific curriculum and observe the students growing skills, abilities, and dispositions / mindsets
- Share with students your checklist of competencies and discuss areas for their growth and development

Summative Assessment

- Test the students' understanding of the learning objectives
- Test the students' comprehension of the story – plot, characters, moral / message, etc.
- Test the students using your formative criteria or a rubric to determine competencies

SAFETY TIPS

Make sure the hand puppets are kept in good condition. Check regularly that

- The puppets are clean
- Any small bits such as buttons and other objects remain firmly attached
- The puppets are in good condition and not needing replacement or repair

ACKNOWLEDGEMENTS

The wonderful tutors in Arua Core Primary Teachers College and the amazing educators in the Arua Region, West Nile, Uganda

https://www.openschoolbag.com.sg/blog/benefits-of-puppet-play/

http://www.learningtoys.ca/benefits-puppet-play

Notes

Sample Resource 9.20
Cardboard Puppets and Small Stages
ENHANCING STORYTELLING BY ADDING A SENSE OF PLACE

RESOURCE DESCRIPTION

Hand puppets can be used with children as an active way to engage them with the characters in a story. Hand puppets are fun and are an easy way to support storytelling to a large group of children. They are also easy to make and share with children.

Hand puppets allow the storyteller to expand beyond an existing story and ask the children what a characters might do next or what else the character might do. Hand puppets support imaginative play amongst the children, and they can be used by the children to create additional stories or other plot scenarios and story endings.

Educators suggest that hand puppets can help to

6. Stimulate children's imagination
7. Support emotional development
8. Improve motor skills
9. Learn etiquette through taking turns and active listening
10. Boost confidence in speaking and asking questions

When you create stages for the puppets, storytelling can be enhanced by adding a sense of place. Storytellers also feel a greater sense of formal performance when they use their hand puppets on a stage or within a setting. The example shown below is set of cardboard puppets with a set. It comes from the Republic of Czechoslovakia in Eastern Europe, where there is a long history of puppetry as a storytelling art form. The two puppets are a King and Queen who are standing in front of their castle. The art work is simple and colourful. The puppets are fastened onto a bamboo stick so the characters

can be easily moved around the set. Details as to how to make these puppets and their set are given later in this resource.

COMPETENCE ADRESSED

- Critical thinking – Encouraging students to ask their own questions about the characters, exploring how the characters might act in different roles or situations
- Creative thinking – Encouraging other stories with existing puppets and creating new puppets and develop their imaginations
- Spatial Literacy – Encouraging the development of small motor skills required for students to make their own puppets

OBJECTIVES

- Develop speaking and listening skills.
- Encourage communication, knowing that children of communicate more easily with puppets, which gives them confidence to express their ideas and feelings
- Develop skills in shy children or children who have experienced trauma to become acquainted with others and gain empathy through the roles they take on using puppets as "their voice"
- Develop skills in children to try on new personalities and take them off again, recognizing that with a puppet on their hand, they can broadening their own in the process.
- Help to develop resilience in children recognizing that scary animal hand puppets like lions and snakes or shy ones such as a tortoise or small birds can help children master uncomfortable feelings
- Develop skills in shy children or children who have experienced trauma to develop resilience and trust through opportunities to gain some control over their world by working out fears and frustrations using a puppet

SUGGESTIONS FOR USING ADULT MADE HAND PUPPETS IN THE CLASSROOM

Directions for simple hand puppets and stage are included in the section below entitled SAMPLE CARDBOARD PUPPETS and SIMPLE STAGE. The directions are written for adults (i.e., teachers, parents, local crafts people, etc.). However, children, depending on their age, motor skills and access to materials, can easily make hand puppets and stages, using found materials.

1. Hand puppets can be used to support the telling of an existing written story or to help illustrate the characters in an oral story. The storyteller can use the puppets to actually tell the story or use the puppets to act out portions of a story.
2. The storyteller can assign a puppet to a member of the audience and ask that person to help the storyteller to tell the story.
3. When using puppets to support language development:
   - Make sure the puppets are telling a good, clear story that has 2 or 3 characters and a simple, easy to follow plot
   - Try to have the puppets repeat lines or rhymes to encourage student interaction, engagement, and anticipation
   - Encourage the students to use the puppets themselves to foster their imaginations and language skills

4. When using puppets to support social / behavioural development:
   - Use the puppets to talk / demonstrate a range of emotions such as pain, fear, joy, aggression, frustration, shame, anxiety, and problems such as illness or death. Be sensitive to the prior experiences of the children in your class as the discussion of these emotions can trigger reactions
   - Recognize that sometimes children who are timid, shy, non-assertive, or victims of trauma can use puppets to express and work through emotions or problems that are difficult for them to talk about or deal with directly. These situations need care and caution and storytellers must be ready to offer support and care if the puppets help the children to discuss or disclose emotional topics
5. When using puppets to support conflict resolution:
   - Use the puppets to support role play and talk about ways in which the puppets can gain empathy, deal with aggression and refrain from bullying
6. When using puppets to foster thinking skills:
   - Ask the children to retell stories to foster their cognitive skills of recall, attention to detail, vocabulary development
   - Ask children to develop their own stories to foster their imagination and creativity
   - Ask children to tell stories together, sharing puppets to foster imagination, creativity and collaboration
6. When using puppets to develop motor skills:
   - Introduce hand gestures, finger movement to develop fine motor skills when manipulating the puppets
   - If you are using a small stage, for the children develop their spatial senses by moving their puppets within the stage space and manipulating the puppets to tell the story

DETAILED STEPS – MAKING CARDBOARD PUPPETS AND A SIMPLE STAGE

MATERIALS NEEDED:

- Cardboard or stiff paper such as used file folders
- White paper
- Glue
- Scissors
- Bamboo sticks or other sticks to support the puppets
- Crayons, felt markers or paint with small brushes

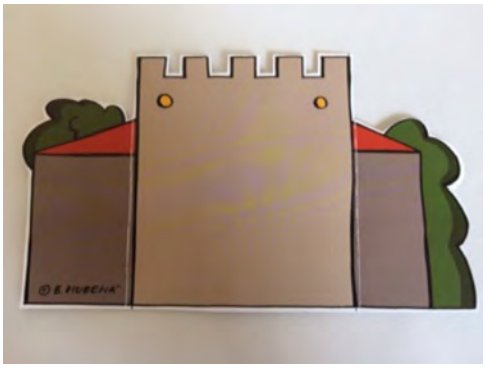
DIRECTIONS

1. Determine how many characters are in your story. The example shared here has four characters – a king, queen, soldier, and storyteller / entertainer.

2. Cut pieces of cardboard for each character that is approximately 9 cm in height and 6 cm in width.
3. Cut two pieces of white paper that are the same size (9cm x 6 cm) for of the 4 characters.
4. Using appropriate and attractive colours, draw and decorate each of your characters on the white paper. You will want to draw a front and a back for your characters so you can turn them around as you tell your story. Add lovely details to each character. For example, the soldier might be carrying a panga or a spear while the king might be holding a staff or fan. It is your decision based on the action in the story.

5. Glue your illustrated characters to your cardboard, creating a front and back side for each character.
6. Attach a bamboo stick to each character using clear tape or glue. The stick allows you to easily move the characters around the set as you tell the story.
7. Cut a piece of cardboard 20 cm by 11cm to create your background set. Carefully fold the cardboard 5cm in from each side. These folds will help to support your set. Cut two pieces of white paper the same size (20 cm x 11 cm).
8. Using appropriate and attractive colours, draw and decorate both sides of your set. In the example shown here, one side of the set is the front of the castle with the entrance gate. The other side of

the set is a simple representation of the inside of the castle.



9. Think about all the creative additions you can make. The children will love the details you add, but there is nothing wrong with just a simple puppet and set to get you started! Details might include
    - Animals
    - Furniture
    - Plants
    - Etc.

If you do not want to make the two sided puppets described in this resource, you could make a two sided set as described in this resource for the paper roll puppets described in the resource Sample Resource 9.19 Hand Puppets.

SUGGESTIONS FOR ASSESSMENT

Informal Assessment

- Observe students as they tell stories using the puppets
- Observe students as they listen to the puppets and ask questions to see if the children can follow the story plot and action
- Note the ways in which the children engage in critically and creative thinking
- Observe the students as they use the puppets to tell their own stories – is there a logic plot; good character development; a clear beginning, middle and ending to the story?

Formative Assessment

- Use a pre-determine checklist of competencies based on your specific curriculum and observe the students growing skills, abilities, and dispositions / mindsets
- Share with students your checklist of competencies and discuss areas for their growth and development

Summative Assessment

- Test the students' understanding of the learning objectives
- Test the students' comprehension of the story – plot, characters, moral / message, etc.
- Test the students using your formative criteria or a rubric to determine competencies

Safety Tips

Make sure the puppets are kept in good condition. Check regularly that they are

- Clean
- Any small bits such as buttons and other objects are firmly attached
- In good condition and not needing replacement or repair

Acknowledgements

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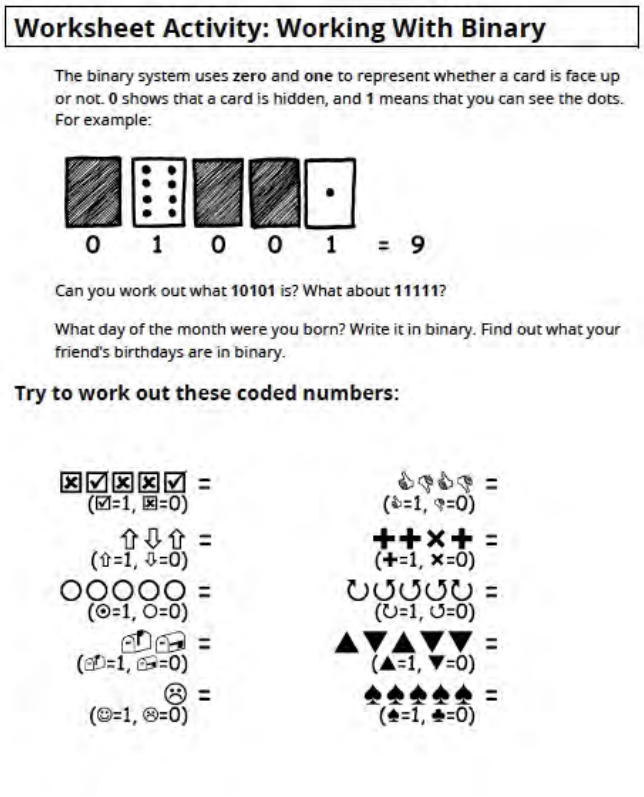
http://www.learningtoys.ca/benefits-puppet-play



Worksheet Activity: Working With Binary

The binary system uses **zero** and **one** to represent whether a card is face up or not. **0** shows that a card is hidden, and **1** means that you can see the dots. For example:

0 1 0 0 1 = 9

Can you work out what **10101** is? What about **11111**?

What day of the month were you born? Write it in binary. Find out what your friend's birthdays are in binary.

Try to work out these coded numbers:

(☑=1, ☒=0) =

(♣=1, ♠=0) =

(⇧=1, ⇩=0) =

(✚=1, ×=0) =

(⊙=1, ○=0) =

(↻=1, ↺=0) =

(▲=1, ▼=0) =

(☺=1, ☹=0) =

(♠=1, ♣=0) =

Sample Resource 9.21
Introduction to Binary Numbers
COMPUTATIONAL THINKING

RESOURCE DESCRIPTION

What is the nature of the digital world? *What skills and technologies are necessary to be a successful digital citizen?* How do computers save information and share that information across the the digital world? This resource introduces binary numbers. Binary numbers are a series of 1's and 0's. In computers, data is stored and transmitted in binary. This resources introduces teachers to a number of classroom activities that do not require computers to complete. These activities challenge the everyday myth that learning about coding is complicated.

These learning activities have been developed by CS Unplugged (http://csunplugged.org) as an open source resource to support computational thinking.

Computational thinking provides a process for teachers and student to formulate a solution to a problem and express the steps to the solution in a way a computer can effectively carry it out. The four stages of computational thinking include

- Decomposition – problem finding
- Pattern Recognition
- Pattern Generalization and Abstraction
- Algorithm Design – finding the most efficient steps to solve the problem

Notes

Section 10: Suggestions for Makerspace Components

Tools and Materials are required for creating *Well-Crafted Local Making R*esources. Here are some suggestions for engaging students in active learning in the classroom.

10.1 EQUIPMENT

- Photocopy machine
- Camera
- Computers
- Scanner
- Photocopy Design Thinking worksheet for participants
- A3 paper for participants
- A4 paper for participants
- Chart paper
- Felt pens
- Pencils for participants
- Pencil sharpeners
- Copy of *When You Give Children Books* (see Sample Resource 9.8 Creating Story Books, Handout #2: *When We Give Children Books* or https://issuu.com/niteoafricasociety/docs/new_sample_01)
- Copy of *Where is Oliver's Goat?* (see Sample Resource 9.9 Creating Picture Books, Handout #1: *Where is Oliver's Goat?* Or https://issuu.com/ubcedo/docs/whereisoliversgoat)

10. 2 HAND TOOLS

- Wood Saw
- Pliers with Wire Cutters
- Clamps
- Steel Rulers (12")
- Utility Knives with Replaceable Blades
- Scissors

10.3 CONSUMABLE ITEMS

- Tongue Depressors
- Bamboo Skewers
- Velcro, if available
- Glue Sticks
- Liquid Glue
- Flour For Papier-Mâché
- 3 Liter Plastic Bowl For Papier-Mâché
- Small Sticks / Wood Scraps
- Cardboard
- Newspaper
- Plastic Bottles Of Various Sizes
- Bottle Caps
- Recycled Styrofoam
- Found Objects That Can Be Used
- Chart And Manila Paper
- Masking Tape
- Brad Fasteners
- Plastic Bottles

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