Didactic Situation-Based Model for Using Student Traditional Handcraft Artefacts to Enhance Meaningful STEAM Education in Tanzania

Musa Saimon
Department of STEM Education, Linz School of Education, Johannes Kepler University
Altenberger Straße 69, 4040 Linz, Austria
Email address: bromusa40@gmail.com
ORCID: https://orcid.org/0000-0003-4758-8270

Thierry (Noah) Dana-Picard
Department of Mathematics, Jerusalem College of Technology
Havaad Haleumi 21, Givat Mordechai 91160, Jerusalem, Israel
Email address: ndp@jct.ac.il
ORCID: https://orcid.org/0000-0002-1777-3232

Fatma Ally
Department of Business Administration, College of Business Education,
Makole Street 2077, Dodoma, Tanzania
Email address: allyfatmaomary@gmail.com
ORCID: https://orcid.org/0000-0001-9163-9552

Zsolt Lavicza
Department of STEM Education, Linz School of Education, Johannes Kepler University
Altenberger Straße 69, 4040 Linz, Austria
Email address: zsolt.lavicza@jku.at
ORCID: https://orcid.org/0000-0002-3701-5068

Guillermo Bautista Jr.
National Institute for Science and Mathematics Education Development, University of the Philippines
&
Quirino Avenue cor. Velasquez, University of the Philippines, Diliman, Quezon City 1101, Philippines
Email address: gpbautista1@up.edu.ph
ORCID: https://orcid.org/0000-0001-5471-9326

Abstract

Aim. The aim of the study was to propose a theoretical model for using students' traditional handicraft artefacts to enhance meaningful STEAM learning in Tanzania. This study was motivated by lessons we learned in our previous project in which we explored the potential of handicraft artefacts from Tanzania in facilitating STEAM learning and realised the need for the model to support teachers in using these materials in the classroom.

Methods. The proposed model is based on the reflection from the Theory of Didactic Situation (TDS) proposed by Brosseau in the 1970s.

Results. We have proposed the model with four phases and provided one illustration on how the model can be applied in the classroom. Our illustration from hypothetical lesson plan for Tanzania context shows various possibilities in which the model can enhance meaningful STEAM learning.

Conclusions. Despite the reported potential of the model, the use of hypothetical lesson plans makes the proposed model less reliable. Therefore, we will report the experience of applying the model classroom contexts of Tanzania in the next study. Furthermore, we call for research insights on applying the model in other relevant classroom contexts as a way to improve the model where necessary.

Keywords: STEAM Education, Mathematics Education, Traditional Handcraft Artefacts, culture

Introduction

The 21st century has dictated that educators transform education practices to cope with the need for skill sets to solve complex problems. Studies show that skills requirements for job markets in the 21st century have increased to the extent that improving traditional teaching approaches is imperative to prepare learners to compete in the current job market (Brejcha, 2018; Trilling & Fadel, 2009). The report of the World Bank (2016, as cited in Brejcha, 2018) showed an increase in new skill sets needed by the job markets between 2015 and 2020. For instance, emotional intelligence and cognitive flexibility were added to skills needed in 2015 such as critical thinking, creativity and complex problem-solving (Brejcha, 2018). As a result, there has been a transformation in teaching approaches to equip learners with needed skills.

Science, Technology, Engineering, Arts and Mathematics (STEAM) education has been identified as one of the approaches that could cater to the demands for new skills in the 21st century. This approach facilitates learners' development of integrated skills through engaging in an authentic learning environment through engaging learning approaches such as Project-Based Learning, and Inquiry-Based

Learning (Armstrong, 2019; Babaci-Wilhite, 2019; Brejcha, 2018). When discussing the relevance of STEAM education in the 21st Century, Lacy Brejcha argues:

> Regardless of whether today's students work in technical careers, become doctors or politicians, or whatever they choose, we know that with the challenges their generation will face, they will be expected to be problem solvers who are educated in science, technology, engineering, art, and mathematics and have excellent soft skills (Brejcha, 2018, p. 45).

This implies the extent to which STEAM education could enhance classroom transformation. Therefore, consequently, educators are adopting STEAM education at various education levels across the globe.

However, there has been a growing body of research that calls for educators to connect STEAM education learners' cultural aspects such as cultural objects and cultural knowledge as a way to enhance meaningful learning (Brown et al., 2021; Brown, 2021; El Bedewy et al., 2021; Hatzopoulos et al., 2017; Liritzis, 2018; Liritzis et al., 2015). Studies show that learning is only meaningful if learners can connect what they learn to their prior knowledge through active engagement and thus can personalise their learning goal (Ausubel, 2000; Howland et al., 2014; Mayer, 2010; Sweller et al., 2011). This shows the importance of cultural aspects in STEAM education that may allow students to find STEAM learning meaningful because of the existing link between the new knowledge and their prior knowledge and the relevance of the new knowledge to their personal goals. For instance, researchers observed cultural artefacts such as cultural buildings (El Bedewy et al., 2021) and cultural stories (Liritzis et al., 2015) enhance meaningful STEAM learning through their connection to learners' contexts and familiarity with learners' knowledgeable community members.

Tanzania is a country that is currently undergoing education reform to enable learners to develop skills needed for job markets of the 21st century. One of the indicators of education reforms in Tanzania is the introduction of the new curriculum in 2023 whose implementation started in 2024. This curriculum is centred with a view to enable schools to facilitate learners to develop skills needed for the 21st century. This is reflected in the Education Sector Development Plan 2025/26–2029/30 as it states,

> The Competence-Based Curriculum at the secondary level is designed to integrate academic knowledge with practical skills, moving away from a sole focus on general education. This dual approach ensures that students are better prepared for diverse career paths, whether they choose to pursue further studies or enter the workforce directly. In fostering practical competencies, the curriculum enhances students' adaptability to the evolving demands of both the job market and higher education (Ministry of Education, Science and Technology, 2025, p.40).

This implies the possibility of adopting a STEAM education approach in implementing the new curriculum in Tanzania.

Towards adopting STEAM education in Tanzania, we anticipate that Traditional handcraft artefacts could be one of the relevant cultural objects to enhance STEAM

learning. This is because the handicraft industry is a common industry to almost all ethnic groups. The Ministry of Industry of Trade and Investment (2016) report shows that Tanzania's handcraft industries are found in almost every district. The list of handcraft artefacts from Tanzania includes basketry, mats, ceramics, beads, pottery, hand-woven textiles and woven products, toys, jewellery, bags, ornaments, and leather products (Ministry of Industry of Trade and Investment, 2016). This means that the use of handicraft artefacts in STEAM learning could cater to the needs of diverse students who would have been disadvantaged by the use of other objects or scenarios that are not accessible or familiar to them. It is also reported that the handicraft industry, despite providing opportunities for self-employment, lags because of low skill levels among the practitioners (Ministry of Industry of Trade and Investment, 2016). This could make students perceive STEAM learning as a catalyst towards successful engagement in the handicraft industry. Thus, STEAM learning can be meaningful to them. In addition to the accessibility and familiarity of handicraft artefacts to diverse students and their relevance to students' economic interest in Tanzania, Musa Saimon et al. (In Press) observed the potential of handicraft artefacts such as pots to facilitate meaningful STEAM learning. However, Saimon et al (In Press) argue that the potential of handicraft artefacts will only enhance STEAM learning if teachers are facilitated with skills and knowledge for integrating the artefacts in the classrooms. Against this backdrop, the present study aims to propose a theoretical model for using students' traditional handicraft artefacts to enhance meaningful STEAM learning in Tanzania. The proposed model is based on the Theory of Didactic Situation (TDS).

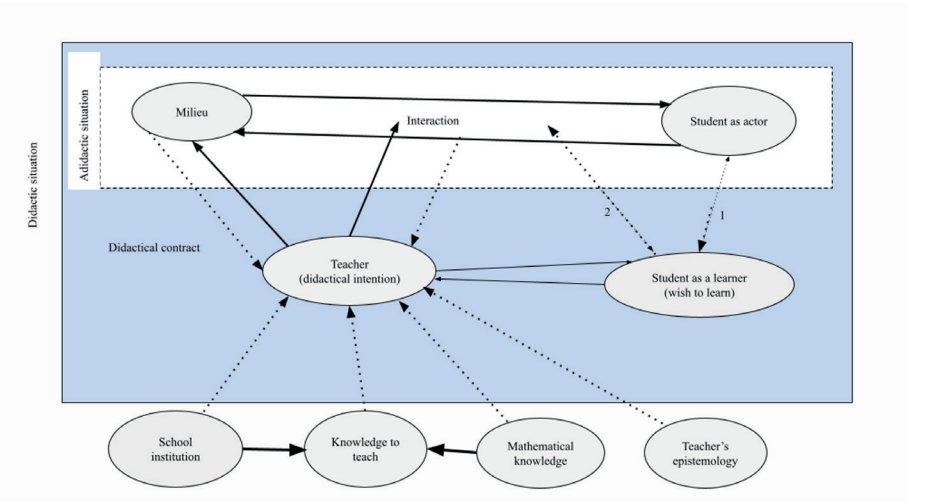
Theory of Didactic Situation

TDS is the theory developed by Brosseau in the 1970s in the context of teaching and learning mathematics (Brousseau et al., 2005; Mangiante-Orsola et al., 2018). According to the TDS, learning is a complex process that can be achieved successfully only if the teacher can guide students in the way that they own the learning task (Brousseau et al., 2005; Mangiante-Orsola et al., 2018). TDS views this process as complex because the ability of the teacher to facilitate learning is determined by various factors including curriculum, content knowledge and students' perceptions (Brousseau et al., 2005; Mangiante-Orsola et al., 2018). These factors in one way or another may compromise learning by limiting the teacher at any point of the facilitation process such as during designing the learning tasks and or implementation of the teaching-learning process. Guy Brousseau et al. (2005) argue that learning is successful when students perceive the learning situation the same way as the teacher does or expects. Brousseau et al. (2005) insist that once the meaning that the teacher draws from the learning tasks is different from students, there is no learning. As a result, TDS requires the teacher to communicate effectively and reflect on the student-learning task interaction to de-

termine the potential need for interventions. The complexity of the learning process is illustrated in Figure 1.

Figure 1

Interaction in the Learning Process Based on a Didactic Situation Theory



Source: Adopted from Mangiante-Orsola et al., 2018, p.149.

Figure 1 illustrates how the teacher is influenced by factors such as school, pedagogical knowledge, content knowledge and epistemology. On the other hand, the teacher is influenced by the students at one level as learners who take information from the teacher and at another level as actors who implement the teacher's instructions. At the level where students take information from the teacher, the role of the teacher is to ensure he/she communicates effectively with students. In contrast, at the level where students implement teachers' instructions, the role of the teacher is to see if there is a need to modify the instruction or the learning task. The situation where students work independently is known as an Adidactic situation while the situation where students take instruction from a teacher is known as a Didactical contract (Mangiante-Orsola et al., 2018).

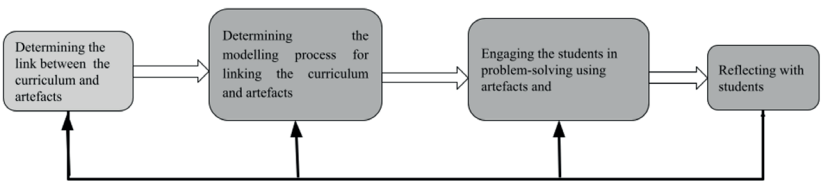
Based on various roles taken by the teacher at different stages, TDS views learning as going through three phases: Devolution, Regulation and Institutionalisation (Brousseau et al., 2005; Mangiante-Orsola et al., 2018). The Devolution phase entails what the teacher does to ensure students own the learning process. In other words, it is where the teacher instructs students on what to do for them to learn successfully. The Regulation entails what the teacher does to support students as they engage in the learning process or they implement his/her instructions. Institutionalisation is what the teacher does to help learners internalise the knowledge used in solving problems in the classroom in a way that can be useful in other contexts. Therefore, TDS

requires the teacher to inform students what they should do based on the curriculum requirements, observe and support students when they implement the instruction, and support them in adapting the knowledge to other contexts.

A Model for Using Student Traditional Handcraft Artefacts

Based on the analysis of the TDS, we propose the model for using traditional handcrafts artefacts in the classroom. The proposed model comprises four phases namely (a) Determining the link between the curriculum and artefacts, (b) Determining the modelling process for linking the curriculum and artefacts, (c) Engaging the students in problem-solving using artefacts and (d) Reflecting with students as shown in Figure 2.

Figure 2
The Didactic Situation-based Model for Using Student Traditional Handcraft Artefacts



Source: Own research

As shown in Figure 2, the first phase is determining the link between the curriculum and the artefacts. This phase requires the teacher to identify how much the curriculum aspects such as content, learning goals, and students relate to the artefacts that he/she wants to use in the classroom. This phase is important because any learning situation must be within the curriculum framework. In the view of TDS, curriculum is one of the aspects that guide teachers' decisions and actions in the classroom. Therefore, in this phase, the teacher has to ask himself/herself questions to see if the artefacts used in the classroom are relevant to the curriculum (students' interest, level of knowledge, learning objectives, strategies and content). The phase of determining the modelling process for linking the curriculum and artefacts entails the need for teachers to design learning tasks and provide rubrics for guiding students on what they are supposed to do. The modelling process is used to denote the act in which students learn in a way that they navigate between real-life and classroom situations simultaneously using handcraft artefacts. In other words, the modelling

process here entails how issues related to handcraft industries can be reflected in the classroom contexts and how the classroom knowledge and skills can be reflected in activities related to handcraft industries. This phase is important because it provides a shared understanding between students and teachers on what students are expected to do during the learning process. For example, the teacher may ask each student or group to collect and come to the classroom with the traditional artefacts they know or prefer. This phase resonates with the Devolution stage of TDS. On the other hand, engaging students in developing problem-solving skills through artefacts is the phase in which students are allowed to work on the given task related to handicraft artefacts while supported by the teacher where necessary. The phase may involve various activities such as searching for information, designing the solution, testing the solution and validating the solution. The support that the teacher provides in this phase is more of facilitating students' inquiry rather than providing solutions to problems that students are engaging in. The teacher's role is to observe students and see if there is a need to modify the learning task or provide more details based on the observation results. This phase is important because classroom contexts are complex in a way that sometimes initial assumptions about the classroom might be insufficient to accommodate learners' needs. We argue that this phase fulfils the requirements for the Regulation stage of TDS. In contrast, reflecting with students is the phase that requires the teacher to work with students to identify successful learning strategies and solutions to relevant problems. We assume that students may have developed different solutions and procedures for their solutions, however, there could be students reaching some conclusions with flawed processes. In this instance, the whole class reflection may help clarify some of the misconceptions to certain students. In addition, this reflection may facilitate the teacher's modification of the learning environment through lessons that he/she draws based on students' reflections. This phase meets the requirement of the institutionalised stage of TDS.

However, it should be noted that the phases of this model are interactive in a way that may move back and forth throughout the process. As shown in Figure 2, the arrows of the model, it implies that reflection is part of all phases. Therefore, in applying this model, there is a possibility that teachers may reach different levels of successful implementation based on how reflective the teacher is.

Illustrations of the Application of the Model based on Tanzania Contexts

In this section, we provide two examples of how the model could be applied in secondary education in Tanzania. The handcraft artefacts used in our illustrations are clay stoves and leather slippers/sandals (See Figure 3).

Figure 3

The Stove clay and Leather Slippers

(a) (b)

Source: Own research.

In our analysis based on the first phase of the model (determining the link between the curriculum and the artefacts), we noted the link between these artefacts and the secondary education curriculum in Tanzania. The functional mechanism of the selected artefacts is relevant to the chemistry and physics syllabus for secondary education (I-IV) on various subjects such as concepts of heat, matter and energy transfer. For instance, the physics syllabus states one of the specific competencies on the topic of heat as "Demonstrate mastery of basic concepts, theories, and principles of Physics." (Ministry of Education, Science and Technology, 2023b, p. 46). On the other hand, one of the specific competencies in chemistry on the topic of combustion states "Demonstrate an Understanding of chemical concepts and principles and their applications in different contexts" (Ministry of Education, Science and Technology, 2023a, p. 12). In addition, the selected artefacts are among the artefacts from the handicraft industry in Tanzania, which makes them familiar to students.

In the second phase of the model, we chose to focus on the marketing-related problem such as branding and advertisement of the artefacts. The research has reported that one of the challenges facing the handicraft industry is the failure to compete in the global market (Ministry of Industry of Trade and Investment, 2016), where branding and advertisement can be one of the factors for the problem. Therefore, this problem could be interesting to students as some of them may have experienced difficulties selling these products in the global market. The modelling process can be done by adapting the assessment frame-

work of modelling by Blum and Leiß (2007). In this framework, the students go through four phases: understanding, simplifying, mathematising and working mathematically. In the understanding phase, learners construct a situation model on their understanding of the problem. The simplifying phase involves the students' creating a structure of the situation into a real model. In the mathematics phase, the learners transform the real model into a mathematical model. The working mathematically phase involves students' use of mathematical tools such as formulas to solve the problem.

To adapt this framework in meaningful STEAM learning students may be required to (a) understand the marketing problem related to the selected artefacts (b) create the structure of the marketing problem (c) transform the marketing problem model into the STEAM model (d) use STEAM-related concept, theories and principles to solve the marketing problem related to the selected artefacts.

In the fourth phase of the model (engaging students in developing problem-solving skills) the teacher can create a group with a reasonable number of students to work together with. Also, in this phase, the teacher will share the rubric to ensure that students understand what they need to do at each phase of the modelling process. Furthermore, the teacher should provide communication ways in which students can see him/her for assistance whenever needed and also how he/she can observe students as they work on the project.

For the last phase of the model (reflection), the teacher may ask students to present their project in the classroom or record and submit the presentation to the classroom-shared platform for feedback.

Based on the proposed learning task, students are likely to develop various solutions to marketing-related issues such as advertisement posters of the artefacts as shown in Figure 4.

Figure 4

An Example of Possible Students' Advertisement Poster for Promoting Artefacts from Handicraft Industries

Source: Own research

Figure 3 shows the advertisement poster with one image of two barefooted walking people captioned *"A comfortable feet protection in all weather?"* and another image of a slipper captioned *"I can & I will"*. This advertisement poster is considered to be one of the students' solutions to marketing of slippers shown in figure 3 (b). When designing this poster, we used Geogebra to model the leather slipper (Bautista, 2024) and we created the image of two barefooted people using You.com™ AI and combined the images using AI Photo Editor. We choose these applications because of their free access and their compatibility with mobile devices such as smartphones.

Engaging students in learning activities like this can help them to develop and apply knowledge and skills from various disciplines in a trans or inter-disciplinary manner. For instance, modelling slippers in Geogebra enables students to learn and apply mathematics concepts such as function in connection to digital skills. Also, the use of You.com™ AI to generate images enhances students' learning of language skills in connection to digital skills. This is because the ability of AI to generate the image that one is looking for is determined by the appropriateness of the imputed descriptions. Overall, the use of AI Photo Editor to design the poster could enable the learners to develop digital literacy skills alongside marketing skills. This is because the learner is required to combine elements of the advertisements (images and texts) in a way that aligns with marketing practices (theory and principles). Furthermore, the marketing practices force the learners to apply scientific principles to justify their/claims in the advertisements. For instance, the claim made in this poster is that leather slippers can provide comfort to human feet in all weather conditions. The claim for the usefulness of leather slippers in cold weather could be supported by fibre-like materials depicted in the straps of the slippers. These fibre-like materials can keep heat that could leave the feet with warmth. On the other hand, the open nature of the slippers allows air circulation which can make them useful in hot weather conditions. These scientific justifications could imply students' application of theories and principles related to the concept of heat in the marketing contexts. Concerning the chemistry and physics syllabus whose emphasis is on students' demonstration of understanding of the concept of heat in various contexts, the task could be regarded to have facilitated learning successfully.

Discussion

The present study has proposed the didactic situation-based model for using traditional handcraft artefacts to enhance meaningful STEAM learning. The proposed model implies the possibility for teachers to facilitate meaningful STEAM learning. The potential of the proposed model to enhance meaningful STEAM learning is reflected in the phases of the model. For instance, the first phase requires the teacher to determine the link between the curriculum and the artefact. This shows the extent to which the model values the learners' connectedness to the learning activities. This is supported by the research report (El

Bedewy et al., 2021; Liritzis et al., 2015) that learners perceive learning as meaningful if it is connected to their culture.

The third phase is another indicator of the potential of the model to enhance meaningful STEAM learning. This phase requires students to solve real-life problems in a way that makes them apply the skills they learn in the classroom in their daily lives. Apart from applying the skills in their daily life, this phase provides freedom for students to decide how they want to solve the problem. For instance, the scenario provided in the illustration of the model shows that students could either decide to create brands or advertisement posters. This shows how the model embraces the aspects of meaningful learning such as ensuring students' personalised goals and relevance to real-life context. According to research reports (Ausubel, 2000; Howland et al., 2014; Mayer, 2010; Sweller et al., 2011), learning becomes meaningful to learners if they are engaged in a way that they can personalize their learning goals.

The fact that the model can enhance learners' engagement in solving problems that require them to integrate integrated skills and knowledge from various disciplines, makes it useful for meaningful STEAM learning. Based on the hypothetical scenario used for the illustration of the model, learners can integrate knowledge and skills from mathematics, science, technology and marketing. Studies show that learning tasks that allow learners to apply skills and knowledge in an integrated manner are considered authentic enough to attract learners' interest (Armstrong, 2019; Babaci-Wilhite, 2019; Brejcha, 2018). Therefore, this serves as evidence of the potential of the proposed model to enhance meaningful STEAM learning with the use of traditional handicraft artefacts.

The present study is similar to other studies (El Bedewy et al., 2021) and (Liritzis et al., 2015) in the sense that it focuses on meaningful STEAM learning through traditional/cultural artefacts. However, this study differs from others because its primary goal was to propose a model for facilitating meaningful learning. In contrast, other studies have shown how traditional artefacts such as buildings (El Bedewy et al., 2021) and stories (Liritzis et al., 2015) enhance meaningful STEAM learning. Based on this, it can be argued that the unique contribution of the present study is to offer insights among educators on how to use handcraft traditional artefacts in the classroom.

However, the proposed model could be questionable as it is rooted in theories rather than practices. Catering to this, the model was accompanied by a hypothetical scenario that illustrates its applicability. We believe that the illustration accompanied by the proposed model could clear some of the potential doubts associated with the model originating from theories. Furthermore, research evidence on the applicability of the model in the classroom context will be reported in our upcoming projects.

Conclusion and Recommendations

This study proposed the didactic situation-based model for using traditional handcraft artefacts to enhance meaningful STEAM learning. The model is accompanied by

illustrations to provide a comprehensive understanding of the model. The requirements of the model through various phases indicate the extent to which the model aligns with the aspects of meaningful STEAM learning. The model has been theoretically developed while considering Tanzania's education contexts. However, the model could be useful in other contexts similar to Tanzania. As the model was developed theoretically, the author illustrated the usefulness of the model through a hypothetical learning scenario involving the secondary education curriculum used in Tanzania. Also, the evidence of the applicability of the model in classroom contexts will be reported in the upcoming projects. We also encourage educators to test the model in various contexts as a way to enhance the modification of the model where necessary.

References

Armstrong, L. (2019). *STEAM Projects Observation, Experimentation, & Presentation*. Mark Twain Media, Inc.

Ausubel, D. P. (2000). *The Acquisition and Retention of Knowledge: A Cognitive View*. Springer. https://doi.org/10.1007/978-94-015-9454-7

Babaci-Wilhite, Z. (Ed.). (2019). *Promoting Language and STEAM as Human Rights in Education: Science, Technology, Engineering, Arts and Mathematics*. Springer. https://doi.org/10.1007/978-981-13-2880-0

Bautista Jr, G. (2024). *Flip Flop*. GeoGebra. https://www.geogebra.org/m/jjmqpnre

Brejcha, L. (2018). *Makerspaces in school: A month-by-month schoolwide model for building meaningful makerspaces*. Prufrock Press, Inc.

Brousseau, G., & Balacheff, N., Cooper, M., Sutherland, R., & Warfield, V. (Eds.). (2005). *Theory of didactical situations in mathematics: didactique des mathématiques, 1970-1990*. Kluwer Academic Publishers.

Brown, B. A. (2021). *Science in the city: Culturally relevant STEM education*. Harvard Education Press.

Brown, B., Pérez, G., Ribay, K., Boda, P. A., & Wilsey, M. (2021). Teaching Culturally Relevant Science in Virtual Reality: "When a Problem Comes, You Can Solve It with Science". *Journal of Science Teacher Education*, *32*(1), 7–38. https://doi.org/10.1080/1046560X.2020.1778248

El Bedewy, S., Lavicza, Z., Haas, B., & Lieban, D. (2021). A STEAM practice approach to integrate architecture, culture and history to facilitate mathematical problem-solving. *Education Sciences*, *12*(1).

Hatzopoulos, J. N., Stefanakis, D., Georgopoulos, A., Tapinaki, S., Pantelis, V., & Liritzis, I. (2017). Use Of Various Surveying Technologies To 3d Digital Mapping And Modelling Of Cultural Heritage Structures For Maintenance And Restoration Purposes: The Tholos In Delphi, Greece. *Mediterranean Archaeology & Archaeometry*, *17*(3), 311-336. http://www2.env.aegean.gr/labs/remote_sensing/EnglishBlock/publications/21_Hatzopoulos-Delphi4Delphi.pdf

Howland, J., Jonassen, D. & Marra, R. (2014). *Meaningful learning with technology* (Pearson new int. ed). Pearson.

Liritzis, I. (2018). Stemac (Science, Technology, Engineering, Mathematics For Arts & Culture): The Emergence Of A New Pedagogical Discipline. *Scientific Culture*, *4*(2), 73-76.

Liritzis, I., Al-Otaibi, F. M., & Volonakis, P. (2015). Digital technologies and trends in cultural heritage. *Mediterranean Archaeology and Archaeometry*, *15*(3), 313–313.

Mangiante-Orsola, C., Perrin-Glorian, M.-J., & Strømskag, H. (2018). Theory of didactical situations as a tool to understand and develop mathematics teaching practices. *Annales de Didactique et de Sciences Cognitives*, *Special issue*, 145–174. https://doi.org/10.4000/adsc.334

Mayer, R. E. (2010). *Applying the Science of Learning*. Pearson.

Ministry of Education, Science and Technology. (2025). *Education Sector Development Plan 2025/26–2029/30*. The United Republic of Tanzania. https://www.moe.go.tz/sites/default/files/ESDP%202025-26%20hadi%202029-30%20Final-%2026%20February%202025.pdf

Ministry of Education, Science and Technology (2023a). *Chemistry Syllabus for Advanced Secondary Education Form V-VI*. Tanzania Institute of Education. https://www.tie.go.tz/uploads/documents/sw-1727192894-CHEMISTRY%20O'LEVEL%20EDUCATION%20FINAL.pdf

Ministry of Education, Science and Technology. (2023b). *Physics Syllabus for Ordinary Secondary Education Form I-IV*. Tanzania Institute of Education. https://www.tie.go.tz/uploads/documents/sw-1727257838-PHYSICS%20FOR%20ORDINARY%20SECONDARY%20EDUCATION%20FINAL.pdf

Ministry of Industry of Trade and Investment. (2016). *Usaid East Africa Trade And Investment Hub: National Agoa Strat-egy For The United Republic Of Tanzania*. Development Alternatives Incorporated. https://agoa.info/images/documents/6213/tanzania-agoa-strategy-final.pdf

Saimon, M., Lavicza, Z., Houghton, T., Prodromou, T., Budinski, N., & Fenyvesi, K. (In Press). Exploring how traditional women's activities in Tanzania can attract female students to study STEAM subjects. *Páginas de Educación*.

Sweller, J., Ayres, P., & Kalyuga, S. (2011). *Cognitive Load Theory*. Springer. https://doi.org/10.1007/978-1-4419-8126-4

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. John Wiley & Sons.