International Journal of STEM Education for Sustainibility, Vol.4, No.2, 2024, pp. 304-318
e-ISSN 2798-5091. DOI. 10.52889/ijses.v4i2.324

An Anthropological Approach to Didactics in Fluid Mechanics Education to Bridge Cultural Contexts and Engineering Principles

Submitted 15 October 2024 Revised 31 July 2024 Accepted 31 July 2024

José Luis Díaz Palencia[1*], Julián Roa González[2]

[1,2]Department of Education, Universidad a Distancia de Madrid, Madrid, Spain

Corresponding Email: *joseluis.diaz.p@udima.es

Abstract

This paper examined how the Anthropological Theory of Didactics (ATD) can improve fluid mechanics education by embedding it within its sociocultural framework. It tackles student misconceptions and promotes a deeper understanding by integrating ATD principles—cultural context, praxeologies, and didactic transposition—into fluid mechanics courses. Five practical activities are proposed to link theoretical concepts with real-world experiences, drawing from daily life, historical contexts, and traditional tools. The findings show that using ATD in fluid mechanics bridges the gap between abstract theories and practical applications, reduces misconceptions, and enhances comprehension. The proposed activities help students relate knowledge to tangible contexts, thereby improving their learning experiences. This research is primarily theoretical and calls for future empirical studies to assess the effectiveness of these activities in various educational settings. The findings suggest that incorporating ATD principles can refine teaching strategies and lead to better student outcomes. Educators are provided with tools to create more engaging and effective learning experiences, which promote problem-solving and collaboration. This approach supports a culturally aware and contextually relevant education system, improving the preparedness of the engineering workforce and potentially influencing educational policy decisions. This paper demonstrates the application of ATD to fluid mechanics, offering valuable insights and practical tools for educators, thus bridging cultural and technical education.

Keywords: Anthropological Theory of Didactics (ATD), Fluid Mechanics, Sociocultural Context, Engineering Education, Didactic Transposition.

INTRODUCTION

The Anthropological Theory of Didactics (ATD) is a framework within educational research that delves into the relationship between knowledge and its embeddedness in sociocultural contexts. Originating in the realm of mathematics education, ATD's scope has since broadened to encompass other disciplines. The foundational tenets of ATD include; Cultural Context of Knowledge: ATD underscores that knowledge is not an isolated entity but is deeply interwoven with cultural, historical, and social contexts (Chevallard, 1999). This signifies that how knowledge is imparted, assimilated, and comprehended is profoundly influenced by the cultural backdrop within which these activities transpire. Praxeologies: A cornerstone of ATD is the notion of 'praxeologies'. According to Bosch & Gascón (2006), the concept of praxeology pertains to the amalgamation of specific tasks (problems) and the methodologies or techniques employed to address them. Distinct cultural groups possess their unique praxeologies, which are transmitted and honed across generations. Didactic Transposition: Supported by the works by Chevallard, Y., & Bosch, M. (2020a; 2020b), this concept highlights the metamorphosis that knowledge undergoes when tailored for pedagogical intents. Knowledge from scholarly or expert domains is transformed to fit into curricular or instructional contexts.

An important aspect to discuss is connected with the confluence of Engineering and the Anthropological Theory of Didactics. Engineering, at its core, deals with the application of scientific principles to design and build systems, structures, and solutions to complex real-world problems. The process is deeply rooted in practicality, precision, and innovation. Anthropological Theory of Didactics (ATD), on the other hand, is a branch of educational research that examines the relationship between knowledge and culture. It seeks to understand how cultural contexts influence the ways knowledge is taught, learned, and understood (Chevallard, 1999). At first glance, these two domains might appear distinct, but a closer inspection reveals a confluence of principles and applications. We present some ideas for understanding the mentioned confluences:

1. Contextual Understanding

Both engineering and the ATD emphasize the importance of understanding context. In engineering, solutions are often tailored to specific environments, taking into account local materials, climate, and cultural issues (for example the norms used in designing artifacts may be different in different countries). Similarly, ATD recognizes that teaching and learning are deeply influenced by cultural contexts, necessitating a tailored approach to education (Lave & Wenger, 1991). Chevallard's concept of teaching through the questioning of the world, as opposed to monumentalism, further underscores the need for contextual sensitivity. Chevallard argues that education should focus on critically engaging with the world and its complexities rather than merely transmitting established knowledge (Chevallard, 2007) and that such an educational process should introduce fertile questions about our daily world (Chevallard, 2013).

2. Collaborative Learning

Modern engineering projects often require interdisciplinary teams. Collaboration is key, and hence a collaborative learning approach can be more effective than individualistic approaches (Vygotsky, 1978). This aligns with the need to modify educational methodologies to better handle institutional constraints and enhance the study environment in the frame of ATD to promote face-to-face interaction and social skills (Roa & Hidalgo, 2020), especially considering cultural aspects.

3. Problem-solving and Adaptation

Engineers are trained problem solvers. They adapt and innovate based on the challenges they encounter. ATD posits that learners, too, are adaptive problem solvers, navigating the

International Journal of STEM Education for Sustainibility, Vol.4, No.2, 2024, pp. 304-318
e-ISSN 2798-5091. DOI. 10.52889/ijses.v4i2.324

complex landscape of knowledge acquisition within their cultural contexts (Bourdieu & Passeron, 1990).

4. The Role of Tools

Just as engineers rely on tools (both tangible and conceptual) to design and implement solutions, ATD recognizes the critical role of cultural tools in the learning process. These can be physical artifacts, symbols, or practices that mediate learning (Wertsch, 1991).

5. Continuous Improvement:

Engineering thrives on iterative processes, constantly refining designs based on feedback and testing. Similarly, ATD promotes the idea of continuous learning, where individuals refine their understanding based on experiences and interactions within their cultural milieu (Rogoff, 1990). Additionally, mathematics is understood by ATD as the construction of praxeologies of increasing complexity, which involve organized practices and the associated theoretical discourse (Chevallard, 2006). Both disciplines emphasize the integration of practical application with theoretical understanding based on increased refinement and complexity.

Indeed, while engineering and ATD may stem from different academic roots, they share fundamental principles that emphasize the complexities of the context. Particularly, in the realm of engineering, it is possible to consider the modeling process that is a core issue in the ATD as well. Artigue (2011) discusses how the ATD has been applied in mathematics education, which can be extended to engineering due to similar needs for integrating theory with practice under a modeling scenario. Expanding on this, the ATD framework in engineering involves cyclic processes where models are not only designed but continuously evaluated and refined based on their effectiveness in real-world applications. This iterative cycle mirrors the engineering design process, which requires both analytical thinking and practical implementation. For example, the praxeological approach within ATD supports engineering students in understanding the dynamics between theoretical models and their practical applications. This helps bridge the gap between academic knowledge and industry requirements, fostering graduates who are better prepared for the complexities of modern engineering tasks. Recognizing these parallels is relevant and provides new perspectives in both domains, promoting innovative solutions in engineering and more effective educational strategies in diverse cultural settings.

Within the different fields of engineering, we will focus on fluid mechanics, a foundational branch of applied physics that delves into the behavior of fluids, encompassing both liquids and gases and the forces they experience. Its significance in engineering cannot be understated. In aerospace engineering, for instance, fluid mechanics is instrumental for understanding aerodynamics, which is essential for the design and optimization of aircraft and spacecraft, determining factors like lift, drag, and overall performance (Anderson, 2007). Similarly, in the domain of civil engineering, fluid dynamics principles guide the design of hydraulic systems such as dams, canals, and sewage systems, as well as flood prediction and water flow control (Chaudhry, 2007). Additionally, in fields like biomedical engineering, fluid mechanics aids in understanding blood flow dynamics and designing medical devices like heart pumps. From the perspective of ATD, all of these transversal areas are seen as a context capable of generating many fertile generative questions for study.

This study serves as a succinct exploration designed to introduce classroom activities that integrate the ATD with fluid mechanics. Leveraging the scope of ATD allows for the execution of tasks from various perspectives, systematically considering the context and the generation of active principles in teaching. The objective is to detail each activity, blending the principles of fluid mechanics with ATD while addressing common student misconceptions. Each activity begins with a brief introduction to ensure clear comprehension of how ATD is applied and contextualized within the framework. This structured approach aims to enhance the understanding and application of both educational theory and engineering principles.

METHOD

The integration of the ATD framework into engineering education can create a learning environment that is both culturally sensitive and technically rigorous and fosters a deeper understanding and appreciation of engineering concepts among students. In particular to Fluid Mechanics and to design effective educational activities for this field using the ATD, we can follow this systematic approach:

1. Assess the Cultural Context of Knowledge:
   - Discuss with previous educators and students about their background. Probably, initiate surveys, interviews, or focus groups to understand students' cultural, historical, and socio-economic backgrounds.
   - Evaluate students' pre-existing notions, beliefs, and misconceptions about fluid mechanics based on their cultural contexts.

2. Incorporate Relevant Fluid Mechanics Praxeologies:
   - Identify key tasks or problems in fluid mechanics that resonate with the students' cultural and practical experiences. For instance, in regions affected by flooding, problems related to fluid dynamics during floods can be pertinent.

- Develop techniques and methodologies that align with both the cultural context and fluid mechanics principles. For example, using locally available materials for hands-on experiments.
- Integrate these praxeologies into the curriculum, ensuring a balance between theoretical knowledge and culturally relevant practical applications.

3. Didactic Transposition in Fluid Mechanics:
   - Adapt advanced fluid mechanics concepts into digestible educational content suitable for the target audience.
   - Ensure that the transposed knowledge retains its core principles while being relatable and understandable within the students' cultural context.
4. Continuous Feedback and Iteration:
   - Regularly collect feedback from students on the effectiveness and relevance of the educational activities.
   - Refine and adapt the curriculum based on feedback, ensuring it remains culturally sensitive and academically rigorous.

Based on these methodological aspects, we propose a set of 5 activities that address the challenge of integrating ATD into the field of fluid mechanics education in subsequent sections.

Students` Misconceptions In Fluid Mechanics

Fluid Mechanics may be regarded as intricate by students and can be challenging for them. Various misconceptions have been identified as that students often hold regarding this subject. Additionally, these misconceptions have been corroborated by the authors through their experience as instructors in fluid mechanics courses:

1. Buoyancy and Archimedes' Principle

Many students, as Stepanek & Moler (2010) point out, believe that only submerged objects experience buoyant forces. They often fail to understand that even floating objects are subjected to these forces and that the buoyant force equals the weight of the fluid displaced by an object, regardless of the object's density.

2. Continuity Equation

A frequent misconception among students is confusing the conservation of mass with the conservation of volume in fluid flow. They might incorrectly think that, in a pipe with varying cross-sectional areas, the volume flow rate changes, even though it remains constant.

3. Bernoulli’s Principle

Students often misconstrue that faster-moving fluids always exert less pressure than slower-moving ones. This misconception can be attributed to a superficial understanding of Bernoulli's equation, which, while it does relate fluid speed and pressure, is specific to streamlining flow and doesn't apply universally.

4. Turbulence

Contrary to popular belief, turbulence doesn't occur only in fast-moving fluids. It can be induced by various factors like fluid viscosity, surface roughness, and flow obstacles, a nuance often overlooked by students.

5. Viscosity

The concept of viscosity is often reduced to the "thickness" or "stickiness" of a fluid. Many students might incorrectly assume that water, being "less sticky" than honey, has no viscosity, not recognizing the complex nature of viscous forces in fluid behavior.

To address these misconceptions, educators must integrate research-based pedagogical strategies to ensure that students understand the concepts while memorizing them.

RESULTS AND DISCUSSION

As previously mentioned the ATD principles in mathematics (especially the notion of modeling) and the engineering (as based in mathematical models) present shared areas of interest for our study. More particularly, an interesting use of ATD, beyond modeling, is the utilization of teaching moments to design activities. These essential moments include the first encounter (presentation of the question), the exploratory moment (seeking tentative solutions based on available means and techniques), the theoretical-technological moment (linking solutions with their theoretical basis), the technique work moment (repeatedly testing the technique to find its utility and limits), the institutionalization moment (collectively deciding on the valid solution for the institution), and the evaluation moment (assessing the degree of acquisition and knowledge of praxeology worked on). These phases are not necessarily sequential, but it is important for didactic proposals to address all of them without underestimating or overvaluing any. Our intention now is to describe each activity, integrating fluid mechanics with the ATD and considering the students’ misconceptions mentioned in the last section. For each of the activities, we introduce a brief explanatory text to properly contextualize the use of ATD (Chevallard, 2006).

Additionally, we underscore that the activities are presented in a manner that supplements the regular curricular activities (and even they can form part of the curricula depending on the course organization). By doing so, each activity can become part of a dedicated period that emphasizes alternative teaching methods. These methods prioritize the meaningful assimilation of knowledge over rote learning, thereby enriching the educational experience.

Such an approach fosters a more holistic learning environment. Students are encouraged to understand and apply these concepts within the context of their own social and cultural backgrounds. This connection between theoretical knowledge and real-world application is relevant for deep learning and for the development of critical thinking skills.

Activity 1. Cultural Context of Fluids in Daily Life:

Objective: Understand fluid dynamics principles through daily experiences and observations.

Activity Description:

Begin the session by projecting images of daily activities or events where fluid dynamics is evident. This can range from pouring a liquid, using a straw, to witnessing rainwater flowing on streets. Ask students to form groups and list similar activities or local events they have encountered. Each group then selects one activity and creates a presentation explaining the fluid mechanics principles at play. For instance, they might discuss viscosity while talking about honey pouring versus water pouring.

ATD Integration:

By using familiar daily activities as a starting point, students can relate their personal and cultural experiences with fluid dynamics, bridging the gap between abstract concepts and tangible experiences. Based on the moments introduced by ATD as previously mentioned, the following encounters shall be considered:

- First Encounter: Present the question by projecting images of fluid dynamics in daily life. Encourage students to think about where they see fluid dynamics in their own experiences. This sets the stage and stimulates curiosity.
- Exploratory Moment: Students form groups and brainstorm daily activities involving fluids. They explore tentative explanations for these phenomena based on their observations and prior knowledge. This collaborative effort helps them connect everyday experiences with scientific concepts and this is particularly interesting if we consider students from different perspectives and cultures that may bring ideas from their life experiences.
- Theoretical-Technological Moment: Groups link their selected activities to fluid dynamics principles. For instance, they might explain how viscosity affects the pouring of different liquids. They utilize theoretical knowledge to explain their observations, grounding their explanations in scientific theory.

- Technique Work Moment: Each group tests their explanations by creating small experiments or demonstrations. For example, they might compare the pouring rates of honey and water to visually demonstrate viscosity. This hands-on approach allows students to see the principles in action and refine their understanding.
- Institutionalization Moment: Groups present their findings to the class. Through discussion and feedback, the class collectively decides on the most accurate and comprehensive explanations. This communal validation process institutionalizes the knowledge gained.
- Evaluation Moment: Finally, assess the students' understanding through both group presentations and individual reflections. Evaluate their grasp of fluid dynamics principles and their ability to relate these principles to daily life. This assessment can include questions that probe their understanding of the praxeology they have worked on.

Activity 2. Historical Water Transportation Systems:

Objective: Explore fluid mechanics principles through the lens of historical water transportation.

Activity Description:

Introduce students to historical methods of water transportation used locally, such as aqueducts, traditional boats, or bamboo rafts. After a brief lecture, divide students into teams and assign each team a method to research. Teams will then assess the relevance of the transportation method and they can use basic equations for the flow in open channels. The session concludes with teams explaining the fluid dynamics principles that made their transportation method effective.

ATD Integration:

By examining local historical transportation methods, students learn about their cultural heritage and also understand the age-old application of fluid mechanics principles in their community. In addition, the following moments are given:

- First Encounter: Present the question by introducing students to historical methods of water transportation in their region. Discuss examples such as aqueducts, traditional boats, or bamboo rafts. This initial encounter aims to pique students' interest and connect them with their cultural heritage.
- Exploratory Moment: Divide students into teams and assign each team a specific water transportation method to research. Encourage them to explore how these methods were constructed and used historically. Teams gather information and brainstorm how these methods utilized fluid mechanics principles such as flow rate, and channel design.

- Theoretical-Technological Moment: Teams link their findings to fluid mechanics principles. For instance, a team researching aqueducts might explain how gravity and water pressure were used to transport water over long distances and how this connects with the Bernoulli equation. This phase involves connecting historical practices with theoretical concepts in fluid mechanics.
- Technique Work Moment: Each team builds mathematical models based on the main variables encountered such as pressure, gravity or surface optimization to reduce drag. This collaborative activity allows students to apply their theoretical knowledge in a practical context. They test their models to see how well they replicate the original methods, observing how fluid dynamics principles come into play.
- Institutionalization Moment: Teams present their models and findings to the class, explaining the fluid dynamics principles that made their historical transportation method effective. Through class discussion and feedback, the students collectively validate the accuracy and effectiveness of each model. This communal validation process reinforces the learned concepts.
- Evaluation Moment: Assess the students' understanding through both group presentations and individual reflections. Evaluate their grasp of fluid dynamics principles and their ability to relate these principles to historical transportation methods. Assessment can include questions that probe their understanding of the praxeology they have worked on and their ability to connect it with historical and cultural contexts.

Activity 3. Local Fluid Challenges:

Objective: Apply fluid mechanics principles to address real-world, local challenges.

Activity Description:

Highlight a fluid-related challenge faced by the local community, such as water scarcity, flood management, or irrigation issues. Begin with a case study or news article discussing the challenge. Divide students into groups and task them with brainstorming and proposing solutions using fluid mechanics concepts. Groups present their solutions, discussing the fluid dynamics involved, potential challenges, and the cultural or social implications of their proposed solutions.

ATD Integration:

Addressing genuine community challenges using fluid mechanics makes the subject immediately relevant and showcases its significance in students' everyday lives. The following moments are then remarked:

- First Encounter: Present the question by introducing a real-world, fluid-related challenge faced by the local community through a case study or news article. This could include issues such as water scarcity, flood management, or irrigation problems.
- Exploratory Moment: Divide students into groups and ask them to brainstorm potential solutions to the presented challenge. Encourage them to explore various fluid mechanics concepts that could be applied to solve the problem, such as fluid flow, pressure, and hydrodynamics. This exploration phase helps students connect theoretical knowledge with practical applications.
- Theoretical-Technological Moment: Each group researches and links their proposed solutions to relevant fluid mechanics principles. For example, a group working on flood management might discuss the use of levees and channels to control water flow. This phase involves grounding their solutions in scientific theory and understanding the mechanisms behind fluid behavior (for instance they can employ Darcy-Fanning coefficients to determine pressure drops).
- Technique Work Moment: Groups develop detailed proposals and possibly simulations of their solutions. They test these models to evaluate their effectiveness and identify potential improvements. This hands-on work helps students apply and refine their understanding of fluid mechanics in a practical context.
- Institutionalization Moment: Groups present their solutions to the class, explaining the fluid dynamics principles involved, the potential challenges, and the cultural or social implications. Through class discussion and feedback, the proposed solutions are collectively evaluated and refined. This process institutionalizes the knowledge gained and validates the practical applications of fluid mechanics.
- Evaluation Moment: Assess the students' understanding through group presentations and individual reflections. Evaluate their grasp of fluid dynamics principles, the feasibility of their proposed solutions, and their ability to consider cultural and social implications. This assessment can include questions that probe their understanding of the praxeology they have worked on and their ability to apply it to real-world challenges.

Activity 4. Fluid Art:

Objective: Understand fluid mechanics principles through local art practices.

Activity Description:

Introduce students to a local art form that utilizes fluid dynamics, such as paper marbling, dyeing fabrics, or certain fluid painting techniques. Invite a local artist for a demonstration or show video tutorials. Students then attempt the art form themselves. Following the art session, discuss the principles of fluid mechanics evident in the art form, like flow rate, surface tension, or capillary action.

ATD Integration:

Merging fluid mechanics with cultural art forms not only makes the learning process engaging but also emphasizes the universality and varied applications of fluid principles. In terms of essential moments as discussed by the ATD:

- First Encounter: Present the question by introducing students to a local art form that utilizes fluid dynamics. This could include paper marbling, fabric dyeing, or fluid painting techniques. It may be of interest to invite a local artist for a live demonstration or show video tutorials to provide a comprehensive introduction.
- Exploratory Moment: Students attempt the art form themselves, experimenting with the materials and techniques demonstrated. They explore how different variables, such as the type of fluid, the method of application, and environmental conditions, affect the artistic outcome. This hands-on exploration allows students to directly observe fluid mechanics in action.
- Theoretical-Technological Moment: Discuss the fluid mechanics principles that are evident in the art form. For example, in paper marbling, discuss how surface tension and flow rate influence the patterns created. In fabric dyeing, explain how capillary action allows the dye to spread through the fabric. This phase involves connecting their practical experience with scientific theory.
- Technique Work Moment: Students refine their techniques based on the principles discussed. They might experiment further to see how altering certain variables changes the results. This iterative process helps them understand the utility and limits of different techniques, deepening their grasp of fluid dynamics.
- Institutionalization Moment: Groups explain the fluid mechanics principles involved. Through class discussion and feedback, students collectively evaluate the accuracy and creativity of the explanations. This communal validation process reinforces the scientific concepts and their application in art.
- Evaluation Moment: Assess the students' understanding through the quality of their explanations of the fluid mechanics principles. Evaluate their grasp of the scientific concepts and their ability to apply these concepts in a creative context. This assessment can

include questions that probe their understanding of the praxeology they have worked on and their ability to integrate it with cultural art practices.

Activity 5. Traditional Fluid Tools and Toys:

Objective: Explore fluid dynamics through traditional toys and tools.

Activity Description:

Showcase traditional tools or toys from the local culture that incorporate principles of fluid dynamics, such as whirligigs, water wheels, or traditional fountains. Provide students with materials to replicate or play with these tools/toys. After a hands-on session, gather students for a discussion on the fluid mechanics principles at play in each tool or toy.

ATD Integration:

By introducing students to the fluid principles embedded in traditional play and daily tools, the activity becomes a fusion of education, culture, and nostalgia. The following moments are remarked:

- First Encounter: Present the question by showcasing traditional tools or toys that incorporate fluid dynamics principles. This could include items like whirligigs, water wheels, or traditional fountains. The initial encounter aims to connect students with their cultural heritage and spark curiosity about the underlying scientific principles.
- Exploratory Moment: Provide students with materials to replicate or play with the traditional tools or toys. Encourage them to observe how these items function and think about the fluid dynamics principles at play. This hands-on exploration allows students to engage with the concepts tangibly.
- Theoretical-Technological Moment: Discuss the fluid mechanics principles evident in each tool or toy. For example, explain how a water wheel converts the kinetic energy of flowing water into mechanical energy, or how a whirligig demonstrates principles of fluid flow and air resistance. This phase involves linking their practical experiences with theoretical knowledge.
- Technique Work Moment: Students refine their replicas or experiments based on the fluid mechanics principles discussed. They might make adjustments to improve the functionality of their tools or toys, deepening their understanding of the principles involved. This iterative process helps them see the utility and limits of different designs.
- Institutionalization Moment: Gather students for a discussion where they present their findings and explanations of the fluid mechanics principles at play. Through class discussion and feedback, students collectively validate and deepen their understanding of

how traditional tools and toys utilize fluid dynamics. This communal validation process reinforces the learned concepts.

- Evaluation Moment: Assess students’ understanding through both the quality of their replicas and their explanations of the fluid mechanics principles. Evaluate their grasp of the scientific concepts and their ability to apply these concepts in the context of traditional tools and toys. This assessment can include questions that probe their understanding of the praxeology they have worked on and their ability to integrate it with cultural heritage.

The integration of ATD with fluid mechanics in these activities allows students to explore fluid dynamics through cultural and historical contexts, connecting theoretical knowledge with real-world applications and providing a didactic framework for the acquisition and construction of engineering praxeologies. Each activity is designed to address common misconceptions by engaging students in hands-on learning experiences that are both relevant and rooted in their everyday lives and cultural heritage.

In activities like "Cultural Context of Fluids in Daily Life" and "Historical Water Transportation Systems," students apply fluid mechanics to understand everyday phenomena and historical engineering, respectively and this aligns with the idea of Artigue (2011). This method helps demystify abstract concepts and enhances student engagement by linking the curriculum to familiar and culturally relevant examples. The "Local Fluid Challenges" activity utilizes ATD to make learning directly applicable to addressing community-specific issues, thereby highlighting the practical importance of fluid dynamics in solving real-world problems as further considered by Vaidya (2021). Similarly, "Fluid Art" and "Traditional Fluid Tools and Toys" merge scientific principles with cultural practices, enriching students' learning experiences and fostering a deeper appreciation of both science and culture.

CONCLUSION

In the dynamic field of engineering education, the application of ATD enhances both the depth and breadth of student learning, particularly in complex areas like fluid mechanics. The approach presented in this work integrates engineering principles within cultural and sociological frameworks and introduces a translation of concepts such as didactic transposition and praxeologies from the field of mathematics to the field of engineering. From the perspective of ATD, engineering is an ideal field for finding real-world problems and fertile questions that can initiate modeling processes in higher-level courses like fluid mechanics.

The activities presented in this article exemplify the synergy between fluid mechanics and ATD. We addressed misconceptions in fluid mechanics and used culturally relevant contexts, to promote deeper comprehension and to cultivate an appreciation for the interdisciplinary nature of engineering. The confluence of culture and engineering underscores the notion that technical knowledge is not an isolated entity but is deeply intertwined with societal and cultural fabrics.

As the world continues to globalize and diversify, embracing such pedagogical frameworks becomes imperative. It ensures students gain technical proficiency while developing cultural sensitivity, preparing them for challenges in a multifaceted global arena. Educators worldwide are encouraged to adopt and adapt these principles, fostering a new generation of engineers who are technically skilled and culturally attuned.

REFERENCES

Anderson, J. D. (2007). *Fundamentals of aerodynamics*. McGraw-Hill Education.

Artigue, M. (2011). The application of the Anthropological Theory of the Didactic in mathematics education. *For the Learning of Mathematics,* 31(1), 39-43.

Bosch, M., & Gascón, J. (2006). The common core of the didactical transpositions. *Irem de Lyon*.

Bourdieu, P., & Passeron, J. C. (1990). *Reproduction in education, society and culture*. Sage.

Chaudhry, M. H. (2007). *Open-channel flow*. Springer Science & Business Media.

Chevallard, Y. (1999). L'analyse des pratiques enseignantes en théorie anthropologique du didactique. *Recherches en didactique des mathématiques, 19*(2), 221-266.

Chevallard, Y. (2006). Steps towards a new epistemology in mathematics education. In M. Bosch (Ed.), *Proceedings of the Fourth Congress of the European Society for Research in Mathematics Education*. FUNDEMI IQS – Universitat Ramon Llull.

Chevallard, Y. (2007). *Readings in the Anthropological Theory of the Didactic.* La Pensée Sauvage.

Chevallard, Y. (2013). La enseñanza de las matemáticas en una encrucijada: por un nuevo pacto de civilización. *I Jornada de Estudios en Educación Matemática, Córdoba: FAMAF*.

Chevallard, Y., & Bosch, M. (2020a). The Anthropological Theory of the Didactic: An introduction. *ZDM Mathematics Education*, 52, 1191-1203.

Chevallard, Y., & Bosch, M. (2020b). Praxeology as a research tool in mathematics education. *Research in Mathematics Education,* 23(2), 121-136.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Roa, J. & Hidalgo, M. (2020). Alternative to monumentality teaching: cooperative REIs. *Educ. Matem. Pesq* , 22, (4), 531-545.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. Oxford University Press.

Stepanek, L., & Moler, M. (2010). Students' misconceptions about buoyancy. *American Journal of Physics, 78*(5), 502-512.

Vaidya, A. (2021). Contributions to the Teaching and Learning of Fluid Mechanics. *Fluids*, 6(8), 269. https://doi.org/10.3390/fluids6080269

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wertsch, J. V. (1991). *Voices of the mind: A sociocultural approach to mediated action*. Harvard University Press.