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The Use of a User in Design Projects

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Abstract

This study examines how user representation is embodied in students' physical models in technology education design projects, and how this relates to the models' function, structure, and overall design.

Given that physical models are widely used in technology education, previous research has paid limited attention to how users become materialised in students' models. Drawing on research that conceptualises modelling as a generative and epistemic activity, this study addresses this gap by analysing 45 physical models produced in a technology course for student teachers. The models were created in an individual design assignment based on a children's book. Two versions of the assignment were used: one requiring student to design a technological solution represented in a model for a specific user within the book, and another using the book purely as inspiration for designing a solution. The models were analysed using an extended analytical framework that included graded categories of user representation model design character and structural representation.

Findings show that user representation decisively shaped the character and overall design of the models. Models with clear user influence displayed explicit structural reasoning and integrated overall designs, whereas models lacking user representation tended to remain exploratory or centred on isolated functions. Importantly, user representation also emerged when not explicitly required, indicating that users functioned as interpretive resources in students' design reasoning. The study contributes empirical and analytical insight into how user-related reasoning becomes embodied in physical models and highlights the need for further research and more robust analytical frameworks for examining physical models in technology education.

Key Words: Design Projects, Physical Models, User Perspective

1 INTRODUCTION

Physical models are mentioned in several countries' curricula for technology, where they serve as key tools for problem solving, communication, and technological development (Norström & Hallström, 2023; Citrohn, 2018). In school design projects, physical models function both as

representations of intended solutions and as epistemic artefacts that support externalisation, testing, and communication of solutions (Citrohn et al., 2023).

Although the use of models is common in technology education, little attention has been given to how users are represented within models. Research in information technology and human-computer interaction shows that users are often constructed through designers' assumptions and that there is a persistent gap between user-centred design ideals and practice (Hyysalo & Johnson, 2015; Oygür, 2018; Mäkinen et al., 2019; Wilkinson & De Angeli, 2014; Marti & Bannon, 2009). Yet little is known about how user representations are embodied in physical models in technology education. From a philosophical perspective, technological artefacts have a dual nature: they are physical objects shaped by human intentions and purposes (Kroes, 2002; Kroes & Meijers, 2006). Thus, a technological model must be understood in relation to its intended user, underscoring the importance of examining how the user influences the model.

In technology education design projects may have a specific user, a user implied through narratives, or a user constructed by students as part of their design reasoning. How students interpret or construct users can therefore shape their modelling practices and the relationship between model and intended solution. Previous research shows that a user influences students' reasoning about function, structure and materials (Citrohn, 2025) and that models designed for a specific user differ from those focused mainly on technical functions (Boström & Citrohn, 2023). However, few studies have examined how such user-related reasoning becomes materialised in students' physical models, or how models differ when users are assigned or self-constructed. In order to addresses this gap this study by analyses physical models created in a design assignment based on children's books, in which one version required an explicit user and the other used the book only as inspiration. This setting makes it possible to investigate both whether students work with a user and how user representation becomes embodied in their physical models.

The purpose of the study is to examine how user representation is embodied in physical models developed in design processes, and to analyse how these embodiments relate to the models' function, structure, and level of integration. Accordingly, the study is guided by the following research question:

> In what ways is user representation embodied in physical models in design processes, and how does this relate to the models' function, structure, and overall design?

2 LITERATURE REVIEW

In Swedish technology education, design projects involving physical models are common, particularly in compulsory school, where design processes including modelling are explicitly stated in the curriculum (Skolverket, 2022). In these projects, models function as representations through which students develop, refine and communicate their solutions. Models enable students to externalise, test and communicate ideas about function, structure and material (Citrohn et al., 2023).

2.1 Technical artefacts, function and use

As technological artefacts, models link physical structure to human intentions and contexts of use. Kroes (2002) argues, when discussing function, one always refers to a context of use and to the user for whom the artefact (model or solution) is intended. With regard to context, Kroes (2002) introduces an important distinction between designer context and user context. In the designer context, a solution's function may fit the design specifications, yet in the user context the same solution may fail to satisfy users' needs, expectations, or constraints. Therefore, designers must consider the user context alongside the designer context (Kroes, 2002). The user context is simply not external to technical artefacts; it is constitutive of what makes them meaningful. This highlights the importance of examining user representations in students' solutions and physical models.

2.2 Physical models and prototypes in design processes

Models and prototypes function as generative, exploratory and communicative artefacts that enable designers to investigate functions, test structural principles and consider use situations. They typically evolve from simple constructions focusing on isolated functions toward more integrated, product-oriented representations (Isa & Liem, 2014), a progression that is also relevant in educational settings where design problems are loosely defined (Citrohn, 2025). As models develop, usability and handling often gain prominence, making the user more visible even when not initially specified. At the same time, research highlights conceptual ambiguity in how models are analysed, creating a need for analytical tools that distinguish intentions, representations, structures and outcomes in students' modelling work (Green et al., 2014).

2.3 Physical models in technology education

As material representations, models shape students' reasoning by highlighting certain functional or structural aspects while downplaying others. Models may be categorised by their properties or by the purposes they serve in the design process (Müller, 2009). In educational design projects, students may engage both the designer's and the user's perspective, and the model's specific design reflects considerations of intended use and intentionality (Nia & de Vries, 2017). An imagined user often becomes essential for expressing design intentions; without one, modelling risks reducing the task to craft or isolated function work rather than technological design (Kimbell, 1996). Depending on how a design assignment is framed, students' models may emphasise form, isolated functions or structural principles (Boström & Citrohn, 2023; Citrohn, 2025). From the perspective of the philosophy of modelling, models are tools constructed to answer specific questions (Rost & Knuuttila, 2022). User representation therefore provides epistemic direction by helping define what the model is intended to investigate. Despite this, how user-related reasoning becomes materially expressed in students' physical models remains an underexplored aspect within technology education.

2.4 Positioning the study

This study examines how user representation is embodied in students' physical models in a technology course for student teachers. Drawing on philosophical accounts of technical artefacts as intentional objects, research on models in design processes, and the need for analytical

frameworks, the study investigates how users influence functions, structure and material of students' models. By analysing physical models as epistemic artefacts and focusing on user representation as an analytical dimension, the study contributes to a deeper understanding of how design assignments shape modelling practices and technological knowledge in educational contexts. In doing so, the study explores how user-centred reasoning, the design and representation of intended solutions in physical models, and didactic relations intersect in technology education. The present study also responds to the gap identified by Norström and Hallström (2023), who show that educational modelling practices rarely make explicit the epistemic stages of simplification, validation and verification. By examining user representation in physical models, the present study extends their call for analytical frameworks capable of connecting modelling decisions to intentionality and context.

3 METHODOLOGY

This study adopts a qualitative comparative design aimed at examining how the inclusion of an explicit user and context in design assignments influences physical models and ideas about intended technological solutions in a technology education context. The analysis focuses on students' physical models developed through design activities.

3.1 Participants and educational context

The participants were student teachers preparing to teach grades 1–3 (children 7 to 10 years of age) in Swedish schools, enrolled in a Technology Education course. A majority of the students had limited knowledge of constructing, materials and tools. The course included workshops on material properties and structural strength, as well as seminars addressing the nature of technology, technological development and design processes. Students' modelling work were conducted in a university technology workshop with access to a variety of tools and materials; also, students were allowed to bring additional materials from home. The students had about 9 hours to design and complete their models.

3.2 The design assignment

The design assignment was based on children's books which were selected and analysed by the students earlier in the course. Two versions of the assignment were used: in the first version, students were instructed to select a character from their book and design a technological solution adapted to that character. In the second version students were instructed to develop a technological solution inspired by the content of their children's book. Apart from the inclusion of an explicit user the versions were otherwise identical. In both versions, students were asked to design and construct a physical model which was supposed to be used when demonstrating their intended solution. When demonstrating the solution, the model was supported by sketches and an oral presentation.

3.3 Empirical material and analysis

The empirical material consists of 45 physical models produced by the student teachers, together with their descriptions of the intended functions. The first 27 models (M1 - M27) are related to

the first version of the assignment while the last 18 models (M28 – M45) are related to the second version. The models were treated as the primary units of analysis but were complemented by student's oral presentation and sketches. The analytical framework builds on previous research analysing physical models as epistemic artefacts used to explore ideas, functions, structures and materials (Citrohn, 2025). In the present study, this framework was extended by introducing *user representation* as a distinct analytical dimension. The analysis was guided by an analytical matrix comprising categories for *user representation*, *structure representation*, and *model category*. Central to the analysis was a graded coding of user representation, capturing the extent to which the user influenced the functional, structural and material characteristics of the models (Table 2).

Each model was analysed individually. Descriptive data were first recorded, followed by analytical coding. Care was taken to distinguish between features explicitly shown in the physical model and aspects that were only verbally described during demonstration. Finally, each model was categorised according to its overall character (e.g. form-oriented, function-oriented or product-oriented), enabling systematic comparisons between models developed in assignments with and without an explicit user. Models were categorised using four model categories (K1–K4), corresponding to a progression from exploratory models to prototype models (Table 1). The categories build on established distinctions between simple, advanced, presentation and prototype models (Isa & Liem, 2014) adapted here for the analysis of students' physical models in educational design projects.

Table 1

Categories of physical models in educational design projects

K1: Exploratory model	K2: Function model	K3: Presentation model	K4: Prototype model
A simple, idea-oriented model for exploring initial concepts without attention to technical accuracy or structural realism. Often built in easily adaptable materials.	A more precise model focused on demonstrating specific functions. Often constructed in durable materials and centred on isolated mechanisms or principles.	A model developed for presenting the intended solution. The user influences included functions, and components are combined into a coherent whole with attention to usability and handling.	An integrated model resembling a prototype. Display strong user representation and brings together function, structure, and material in a cohesive product-oriented model.

The two versions of the design assignment differed in whether a specific user was explicitly supposed to be used in the assignment. However, user representation was not treated as a direct outcome of assignment design. Instead, the analysis focused on whether and how a user was constructed and represented in the physical models. Thus, models developed in the version without an explicitly defined user could still be coded as containing user representation if students themselves introduced a user during the design process. In this way, user representation was

analysed as an emergent feature of students' designing and modelling practices rather than as a predefined condition of the assignment.

Table 2

Analytical categories used in the study

Dimension	Code	Description
User representation	U0	No user represented in the model
	U1	User mentioned when demonstrating but not influencing the model
	U2	User influences specific functions
	U3	User influences both function and structure
	U4	User permeates design (function, structure, material, use)
Structure representation	S0	No structural aspects represented
	S1	Structural aspects partially represented
	S2	Structural aspects clearly represented
Model category	K1	Exploratory model
	K2	Function model
	K3	Presentation model
	K4	Prototype model

3.4 Disclosure section

Generative AI was used as a tool for sound boarding ideas, translation and copy editing.

4 RESULTS

The analysis of the physical models reveals systematic relationships between user representation, model character, and knowledge expressed through modelling. Rather than reflecting assignment instructions alone, these patterns highlight how students actively constructed and worked with the user of the intended solution as part of their design process.

4.1 User representation beyond assignment design

Although the assignment differed in whether the students were instructed to use a user, user representation emerged across both sets of models. Many students assigned to version 2 of the assignment introduced a hypothetical user during the design process and used this constructed

user to inform decisions about the intended solution's function, structure, and form. This finding indicates that user representation cannot be understood solely as a consequence of instructional framing. Instead, the user often functioned as a design resource that students mobilised in order to make sense of the design problem and structure their modelling activity.

4.2 User representation and model character

A clear pattern was identified between the degree of user representation (U) and model category (K). Models with low or absent user representation (U0–U1) were predominantly categorised as exploratory or function-oriented models (K1–K2). These models typically focused on isolated technical ideas or single mechanisms, for example rolling wheels, lifting devices, or motor-driven solutions. Even when technically advanced functions were present, the lack of a clearly articulated user limited the development of integrated, product-oriented models. In contrast, models characterised by higher levels of user representation (U3–U4) were often categorised as presentation models (K3). In these models, students' intentions became visible not only in how they designed functions, but also in how they actively considered the user. The models showed deliberate attention to usability, safety, stability, and handling, indicating that students sought to integrate the user into the design in a coherent and purposeful way. For example, the models contained safety features as safety rails, mechanisms that could be operated by the user and extra stable constructions for heavy users. These aspects were frequently made explicit in the models, suggesting that the user played a central role in how students organised and communicated their design ideas. Only a small number of models approached a prototype-like character (K4). These models combined strong user representation with an integration of function, structure, and material, indicating that prototype-oriented modelling emerges when the user becomes a dominant organising principle in the design process.

4.3 Structure as a materialisation of user-related reasoning

Structural aspects were closely connected to user representation. Models with limited or no user representation rarely showed clear structural considerations (S0–S1), whereas models with strong user representation almost exclusively displayed explicit structural representation (S2). In these cases, structure was used to adapt the solution to the user, for example by addressing weight, stability, safety, or reach. This suggests that structure as a mediating dimension through which user-related reasoning becomes materialised in the physical model. Rather than being an independent technical concern, structural modelling gained prominence when students reasoned about how their intended technological solution would be used by a specific user.

4.4 Summary of results

Taken together, the results show that user representation plays a decisive role in students' modelling practices, regardless of whether the user was explicitly defined in the assignment. While the presence of a user does not guarantee functional accuracy or material realism, it consistently shapes what students choose to model and how different aspects of technology contribute to the overall design of the solution. Models in which a user was actively constructed were more likely to express structural reasoning, integrated solutions, and intentions about a final product, whereas models without a clear user tended to remain exploratory or focused on isolated technological functions.

5 DISCUSSION AND CONCLUSION

The findings show that user representation influenced how students' models developed, clarifying how modelling mediates relationships between function, structure and use. When the user was represented, functional and structural choices aligned with intended use, while models without a user tended to remain exploratory or focused on isolated functions. These results support models as epistemic artefacts—tools that guide reasoning rather than depict reality (Rost & Knuuttila, 2022). Specifying a user provides epistemic direction by defining the questions a model addresses, which helps explain why user-embodied models progressed toward presentation- and prototype models, whereas models lacking a user often remained exploratory or function-focused.

The study extends earlier work on the generative and integrative role of physical models (Isa & Liem, 2014) by showing that user representation can drive the shift from simple models to more coherent prototypes. When user considerations strongly shape the design, models tend to become more integrated and structurally deliberate. In line with Green et al. (2014), the study also demonstrates how an analytical framework can systematically compare different dimensions of modelling. Methodologically, it shows how relationships between students' intentions, representations, and material artefacts can be operationalised. The findings further connect to Norström and Hallström (2023), who argue that key epistemic stages in modelling often remain implicit. This may account for the variation observed in students' approaches. Their six-step framework highlights the need for clearer scaffolding, and this study suggests that user representation constitutes an additional, and currently underdeveloped, epistemic dimension.

The present study refines research on model dimensions in technology education (Citrohn, 2025; Boström & Citrohn, 2023) by adding the user representation as a decisive dimension alongside function, structure and materials. Even in assignments without an explicit user, students introduced their own users to make the design problem meaningful, suggesting that user-centred reasoning may be a natural part of students' modelling practices to make sense of open-ended design projects. Yet the variability across models indicates that user representation does not arise automatically and that explicit scaffolding may be needed to help students connect user needs to functional and structural decisions.

In conclusion, this study shows that user representation significantly shapes the development and character of physical models in educational design processes. User-related reasoning appears to support more coherent and well-developed models, while its absence is associated with exploratory or function models. The study identifies user representation as a key analytical and pedagogical dimension in technology education. Further research is needed to investigate how user-centred modelling can be supported and how analytical frameworks for categorising and interpreting students' models can be further developed. These frameworks are essential for clarifying how modelling mediates the relationships between intention, function, structure, material, and use — core components of technological knowledge in education.

This study involves student teachers which introduces limitations regarding generalisability, as their reflective and theoretical framing differs from that of pupils. Nevertheless, the study highlights the pedagogical potential of making user representation explicit in technology education, both as a driver of model development and as a means for supporting students in integrating function, structure and use.

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