

METHOD FOR ASSESSING THE INGENUITY OF LOW-TECH DESIGNERS IN THE CONTEXT OF A STUDENT HACKATHON

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ABSTRACT

In response to socio-ecological challenges, various alternative design approaches have emerged, each bringing a different set of pedagogical practices to pass on to future designers. One of the most recent of these is the Low-Tech approach, characterised by the ingenuity designers demonstrate in creating solutions within constraints. However, the capacity for ingenuity in this context has not yet been studied, nor is there a method for assessing it. This hinders its transmission to future designers. Against this backdrop, and within the framework of emerging teaching practices to introduce the Low-Tech approach, this study proposes investigating and characterising two components of ingenuity as factors in the success of a design project: the influence of handyman-engineer logics, and the self-imposition of ethical constraints in the design process. The experiment involved tracing the evolution of these components in students over two Low-Tech hackathons. Data was collected from students and coaches using questionnaires and semi-directive interviews. An evaluation grid was also sent to the hackathon jury to assess the Low-Tech characteristics of the solutions. This research aims to characterise and evaluate the components of ingenuity in a Low-Tech context as part of an innovative educational approach and offer initial ways to facilitate their transmission to future designers.

Keywords: Ingenuity, low-tech, education, assessment, design for sustainability

1 INTRODUCTION

In response to socio-environmental challenges, various alternative design approaches have emerged [1, 2], bringing with them a variety of pedagogical practices to pass on to future designers. Among the most recent approaches, the Low-Tech approach [3, 4] is still struggling to become more widespread. Several factors, such as a lack of clarity surrounding its definition [5], can explain this phenomenon and the subsequent difficulty in creating pedagogical approaches aimed at transmitting it. To address this issue, this study focuses on a common trait of low-tech designers: their ingenuity. In the scientific literature, ingenuity is defined as follows: 'The ability to create innovative solutions within constraints using limited resources and imaginative problem solving' (adapted from [6]). The results of this paper are based on previous research defining the ingenuity of Low-Tech designers [7], which proposed two elements that distinguish this ingenuity from that found in more conventional contexts (e.g. industry). Low-tech designers' ingenuity is characterised by self-imposed ethical constraints during the design process, and by a closer proximity to the logic of the bricoleur than to that of the engineer. As the underlying aim of this work is to contribute to the development of teaching practices that communicate this ingenuity to new generations of designers, the next step is to assess the impact of the components of ingenuity in a pedagogical context. This paper has the dual objective of testing a method for assessing ingenuity components and an educational framework for applying this method: the hackathon. The next section provides an overview of the state of the art, setting out the background to the various theoretical elements studied in this work. The method used to build the evaluation system is then described, followed by the results of the various evaluations conducted during the hackathons. Finally, the discussion will question the evaluation method and the relevance of the hackathon framework for this evaluation of ingenuity, before drawing conclusions.

2 LITERATURE REVIEW

To better understand this research, it is necessary to explain the two components of Low-Tech designers' ingenuity. Siqueira and Honig [8] add self-imposed ethical constraints to the main constraints that characterise ingenuity (structural, resource and time constraints [6]), defining them as follows: 'Restrictions on the behaviour of individuals deriving from moral, social and environmental responsibility' [8]. Lederlin [9] updated the logics of the bricoleur and the engineer based on Claude Lévi-Strauss's work in the 1960s [10]. These two logics propose two a priori contradictory ways of thinking, driven by divergent visions. In the engineer's logic, the end — the solution to the problem — is defined using a scientific approach (e.g. calculations and protocols), and then the means to achieve the solution are allocated (fixed solution). In the bricoleur's logic, the solution is initially vague and then materialises according to the available resources (an evolving solution as the project progresses). While the engineer looks for performance (economic, technical, etc.) through various means of optimisation, the bricoleur produces robust solutions that are in tune with their environment [10]. Although creativity and innovation are widely assessed using established methods such as the Torrance Tests of Creative Thinking (TTCT), the Creativity Assessment Packet (CAP) and the Innovation Competence Barometer [11, 12], there is a lack of assessment tools for ingenuity in the scientific literature. Furthermore, the core components of ingenuity in Low-Tech contexts are either insufficiently addressed as ethical considerations [8] or entirely overlooked as the practices of tinkerers and engineers. Consequently, a novel assessment method for low-tech ingenuity was required. The practical constraints of conducting an initial experiment, combined with the availability of two hackathons, resulted in the decision to adopt the hackathon format. These brief, intensive team events focus on developing solutions and facilitate the rapid transition from concept to prototype within a condensed timeframe.

3 METHODOLOGIES

The data was collected during two hackathons held in eastern France in summer 2024. The first took place in Châlons-en-Champagne over five days, and the second in Nogent over three days. The Châlons hackathon was organised as part of a European research project aimed at developing educational practices around Low-Tech. Around 30 students from three countries (France, Ireland and Belgium), who were nearing the end of four- or five-year engineering, management and design courses, took part. The Nogent hackathon involved 14 students who were in their first year of engineering studies. The study includes three of the six groups from Châlons (12 students) and all of the students from Nogent (four groups, 13 students). At the end of both hackathons, the students had to give a short presentation to a jury to showcase their solutions. The two hackathons were conducted in markedly different ways. In Châlons, students had to select one of eight topics identified in a study of local residents and authorities. In contrast, the Nogent hackathon involved the students choosing from a list of everyday product-related topics to which a Low-Tech approach was to be applied. Table 1 shows the subjects chosen by all the groups in both Châlons and Nogent. During both hackathons, the students were given periods of autonomy interspersed with coaching and theoretical input on Low-Tech concepts. However, this theoretical input was too different to be comparable. In Châlons, the hackathon was organised in partnership with a 'ressourcerie' and a 'matériauthèque': places where people can store and reuse donated second-hand materials. The students had the opportunity to select objects from these two places to use in creating prototypes of their solutions. Another difference compared to the Nogent hackathon is that the students in Châlons were already well aware of socio-ecological and Low-Tech issues.

Table 1. Distribution of groups, coaches and juries

Hackathon	Group	Number of students	Subject
Châlons	1	4	Promoting Local Agriculture and Reducing Packaging Waste
Châlons	2	4	Promoting Local Agriculture and Reducing Packaging Waste
Châlons	3	4	Digital Inclusion and Sufficiency in Rural Areas

Nogent	4	3	The private swimming pool
Nogent	5	3	The coffee machine
Nogent	6	3	The headlamp
Nogent	7	4	The camping tent

As the definition of the first component, 'self-imposed ethical constraints', is very broad, it has been adapted for this study, which is focused on pedagogical practice. It was therefore decided that the ability to self-impose ethical constraints would be equated with designers' mastery of certain Low-Tech-specific skills. To this end, this work is based on an initial Low-Tech designer skills reference framework [13], which was developed as part of a European project. This framework is based on a literature review of the different skills required of a sustainable engineer, which was then adapted to the Low-Tech context (see Table 2). The 11th skill, 'Topical Knowledge', was not assessed because the areas of knowledge involved are not clearly defined.

Table 2. LT4Sustain Low-Tech designer's skills model [13]

Skill 1	Systems thinking
Skill 2	Futures and anticipatory thinking
Skill 3	Values thinking and ethics
Skill 4	Strategic thinking
Skill 5	Interpersonal management
Skill 6	Multi-disciplinary problem-solving
Skill 7	Implementation (Design, Action & Assessment)
Skill 8	Intra-personal competence/Self efficacy
Skill 9	People-centeredness and behavioural change
Skill 10	Commons management and solution scaling
Skill 11	Topical knowledge

Then, three levels of acquisition have been defined for each macro-skill, accompanied by validation aids for each level. These levels were defined based on the reference framework for sustainable engineering competences of the University of Technology of Troyes. Table 3 shows the different acquisition levels for Skill 1 as an example. For the second component, as the bricoleur/engineer logic is an emerging topic, the authors did not have a reference framework with which to evaluate it. Therefore, it was deemed too complex to ask trainers or students to carry out an in-depth evaluation.

Table 3. Presentation of acquisition levels for skill 1

Skill	Systems thinking
Definition	Be able to work in your field as part of a complex system that is closely related to other domains like your society, economy, and the environment; and to be able to think about your field on different scales from local to global.
Level 0	No knowledge
Level 1	Identify the contours of the system under study (impacts on planetary limits, impacts on the local economy, on user behaviour, etc.)
Level 2	Understanding and analysing a prospective scenario and its context
Level 3	Have a systemic vision and the ability to analyse critically

The proposed method, presented in Figure 1, involves gathering data on the bricoleur/engineer positioning of students within the different groups studied, as well as their level of proficiency in Low-Tech skills. In order to assess ingenuity, it is also necessary to determine which groups produced solutions that were most in line with the Low-Tech model. The method was based on self-assessment by the students, while retaining critical evaluation by experts (coaches and juries). The evaluation took place in two stages: at the beginning and end of the hackathon, to identify any possible changes.

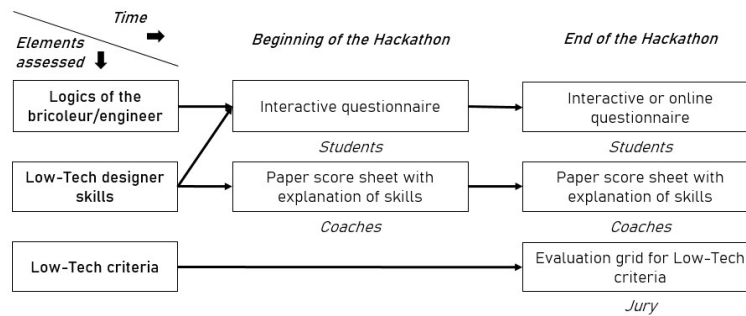


Figure 1. Data collection process

Only the students assessed the bricoleur and engineer logics. The low-tech skills were assessed by both the students (individually) and the coaches (in groups) to obtain two opinions. Skill 8, 'Intra-personal competence/self-efficacy', was assessed only by the students, as it was too personal for an external judgement to be relevant. Self-assessment in the form of interactive questionnaires was chosen to allow students to ask questions about elements they did not understand. The questionnaires began with a short introduction to the bricoleur and engineering logics, followed by a request for the students to position themselves. This was followed by a presentation of the Low-Tech skills and a self-assessment for each skill. The coaches carried out an evaluation at the beginning (end of day 1 or 2) and at the end of the hackathons (and halfway through for Châlons), using paper assessment forms created for this purpose. For the two hackathons, a panel of juries assessed the final solutions based on the deliverables according to the Low-Tech Criteria Grid. This grid was created using literature [3] and comprises eight low-tech evaluation criteria and their definitions. In Nogent, the jury comprised the two coaches and two external members who were considered experts in Low-Tech. In Châlons, the jury comprised eight external members: Two Low-Tech experts (practitioners); four members with an interest in or close links to Low-Tech; and two novice members (their ratings were not taken into account for reasons of consistency).

4 RESULTS

The assessment of the solution at the end of the hackathons (Figure 2) shows that, on average, the groups in the Châlons hackathon (shades of blue) are better rated than the groups in the Nogent hackathon (shades of orange). Furthermore, greater disparities in final marks have been observed in Nogent. This is not surprising, given that students from Châlons come from programmes with a stronger focus on sustainability. This minimises inconsistencies in their understanding and implementation of related concepts, as illustrated by the more varied marks achieved by the Nogent groups. Unfortunately, the Châlons scores were compiled without one jury member who did not follow the marking instructions, and without another jury member for group 2 as he did not mark this group. This has a detrimental effect on the validity of the results.

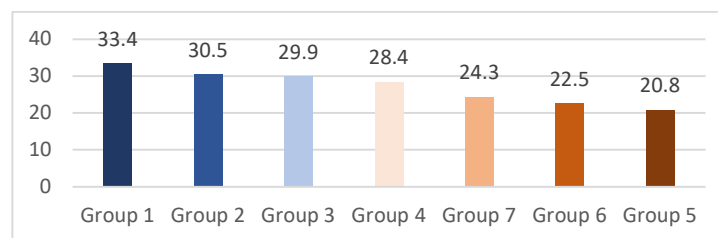


Figure 2. Jury ratings for group solutions based on Low-Tech criteria (marks out of 40)

The results of the Low-Tech designers' skills assessment demonstrate that the Châlons teams obtained higher average scores at the start of the hackathons, according to both students and coaches (see Figure 3). However, for the Nogent groups, the comparison was only made for skills 1, 2 and 4, as the coaches were unable to observe skills 3 and 5–10 at the start of the hackathon. This severely limits the interpretation of the results. For example, due to the significant amount of missing data, it is not possible to substantiate the hypothesis that a better starting level in Low-Tech skills leads to a better rating by the final jury with confidence. Nevertheless, it can be observed that, in general, students and coaches do not agree on these assessments. With the exception of groups 3 and 4, coaches rated students notably

lower across all groups. It could be argued that, as the coaches were considered more experienced in Low-Tech and related skills, the students may have overestimated their abilities in relation to their actual level. This may be because the students were unfamiliar with Low-Tech skills and only had a few minutes to self-assess.

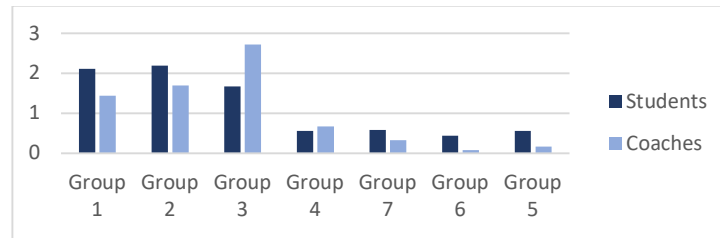


Figure 3. Comparison of skills levels between students and coaches' assessments (except for skill 8 as only the students rated it)

With regard to the influence of bricoleur and engineer logics, Figure 4 shows that there is no correlation between proximity to the ingenuity component (i.e. being closer to the bricoleur logic) and a better rating by the final jury. However, all the groups were relatively heterogeneous, with the exception of group 2. The research method and sample size do not permit identification of the actual influence of each individual and their logic within the groups. Nor do they enable verification that the logic claimed by each designer is the same as that which they actually followed during the hackathon.

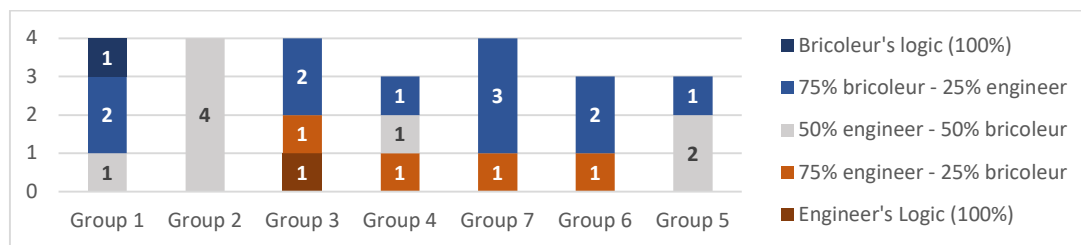


Figure 4. Positioning of students on the bricoleur/engineer logic at the start of hackathons

Finally, the cumulative progress of each group in all the skills over the course of the hackathons was calculated (negative progress results were excluded from the sum of progress). Unfortunately, despite various reminders, three students from the Châlons hackathon and four students from the Nogent hackathon did not complete the end-of-hackathon questionnaire. One student in groups 2–5–6 and two students in group 1–7. For the Nogent groups, the coaches' ratings did not provide a reliable average for skills 3, 6 and 7. For other skills, if one of the coaches has selected 'competence not observed' for a group, only the other coach's mark is considered. Consequently, the Nogent group results exclusively encompass skills 1, 2, 4, 5, 9 and 10. In contrast, the Châlons groups (1 to 3) comprise all skills except skill 8, thereby effectively constraining comparability between the two samples. The proportion of missing data is so high that it is difficult to draw any conclusions about changes in skills. However, it appears that all the groups have made progress, according to the coaches and students.

5 DISCUSSIONS

This study introduces a preliminary approach to assessing ingenuity. Although it is subject to inherent biases and lacks extensive prior research, it enables a partial evaluation and identifies key factors. Adopting a multi-perspective approach, with students and coaches assessing skills and a panel evaluating solutions, helps mitigate biases, particularly those arising from self-assessment. The findings suggest that the methodology requires comprehensive revision and highlight several potential improvements. Enhancing the assessment method may require an increased sample size, more diverse data sources and addressing missing data. The Low-Tech Skills Model also has limitations: coaches found some skills to be too broad, poorly defined or unsuitable for the hackathon context, which makes reliable assessment difficult — especially for skills 2, 3, 6 and 7. Consequently, refinement of the skills model is necessary. Additionally, initial qualitative findings reveal complex and poorly understood interactions between bricoleur and engineer logics. This indicates a need for clearer definitions and

observable markers for each logic. Examples of these markers could be the use of scrap materials for the bricoleur and the production of precise documentation for the engineer [9]. While the hackathon format encompasses multiple design stages, it is too brief for the in-depth evaluation of ingenuity required, and logistical constraints complicate data collection. Thus, the relevance of the hackathon for developing or assessing Low-Tech skills remains unproven. Future work should consider applying the assessment method in other educational contexts, particularly over a longer period to better evaluate changes in Low-Tech skill indicators, or even moving beyond the student environment into the professional world to improve indicator reliability and validity

6 CONCLUSIONS

The aim of this work was to propose and test a method for evaluating the ingenuity of Low-Tech designers but also to test a framework for applying this evaluation method. The method used was designed to assess the 2 components of ingenuity as factors in the success of a Low-Tech project during hackathons: the influence of bricoleur-engineer logics and the self-imposition of ethical constraints during the design process. This work contributes an initial method for assessing ingenuity in a Low-Tech context, as well as experimenting with this method in the context of a hackathon. It opens up many possibilities as further refinement of the method is required to minimise bias and improve its validity, but also to enable a more accurate assessment of ingenuity. The relevance of the hackathon format for assessing ingenuity remains questionable, opening the door to experimentation in other contexts, both with students and with experienced designers in professional settings.

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