EP-JOURNALS

GLOBAL JOURNAL OF EDUCATION, FINANCE & MANAGEMENT

Available on: https://gjefm.ep-journals.org/ E-ISSN: 3117-6771, P-ISSN: 3117-6763

Global Journal of Education, Finance and Management

Volume: 02 Issue: 06 June-2026

Competitions, Tangible Projects and Experiential Learning in Vocational Education: A Qualitative Case Study

Victoria Bonareva

Independent Researcher / Primary and Secondary ICT Teacher, Athens, Attica, Greece, https://orcid.org/0009-0003-2375-9036

Athanasios Patropoulos

Principal of the Unified Special Vocational Gymnasium–Lyceum, Messolonghi, Greece, https://orcid.org/0009-0002-9639-4384

Nikolaos Domouchtsis

Electrical Engineering Teacher / Primary Education Teacher, Serres, Greece, https://orcid.org/0009-0001-7944-8064

Published Date: June 29, 2026 **DOI: 10.65150/EP-gjefm/V2E6/2026-12**

ABSTRACT: This study explores student participation in a National Open Technologies Competition as an experiential learning experience in vocational education. The research focuses on how the creation of a tangible technological project influenced students' learning, collaboration, confidence and understanding of technology in practice. A qualitative case study design was adopted, involving eight vocational upper-secondary students from a public vocational school in Greece. For all participants, this was their first experience of taking part in such a competition. The preparation process lasted eight weeks, with one weekly three-hour meeting, during which students worked collaboratively on the design, programming, testing and completion of an Arduino-based accessibility-oriented technological project. Data were collected through semi-structured student interviews, the teacher's reflective diary and photographic material from the programming and construction process. Thematic analysis showed that students initially experienced insecurity and self-doubt, but gradually became more actively engaged. The findings indicate that the tangible project helped students connect theoretical programming knowledge with practical application, develop collaborative problem-solving skills, persist through trial and error, and strengthen their self-confidence. The successful completion of the project and the distinction received in the competition further enhanced students' sense of achievement and recognition. The study highlights the pedagogical value of student competitions and tangible projects as contexts for experiential learning in vocational education.

KEYWORDS: experiential learning, vocational education, student competitions, tangible projects, open technologies, Arduino

1. INTRODUCTION

Vocational education is currently called upon to connect school knowledge with real-world situations, practical skills, and authentic social and workplace problems. Particularly in vocational upper-secondary education, where learning is directly linked to technical subjects, professional practices, and applied skills, students require learning environments that go beyond the mere transmission of theoretical knowledge. Developing tangible projects, using technological tools, and participating in authentic activities can enhance the meaning-making of knowledge, as students are challenged to design, test, collaborate, and solve real-world problems.

Experiential learning emphasizes learning through experience, action, and reflection. According to the relevant literature, students learn more effectively when they are actively engaged in processes where knowledge does not remain abstract but is transformed into action, trial, and application (Kolb & Kolb, 2005). Similarly, active learning in science, technology, engineering, and mathematics has been linked to improved academic performance and greater student engagement in the learning process (Freeman et al., 2014). In the same context, project-based learning is considered a pedagogical approach that allows students to investigate complex questions, assume roles, produce a concrete outcome, and connect school knowledge with real-world applications (Kokotsaki et al., 2016).

The creation of tangible technological projects further strengthens this connection between knowledge and practice. The literature on the maker movement and makerspaces demonstrates that the process of making can serve as a powerful learning environment; students are not limited to consuming ready-made knowledge but are actively engaged in creation, experimentation, the revision of ideas, and collaborative problem-solving (Halverson & Sheridan, 2014; Sheridan et al., 2014). In such learning conditions, failure does not necessarily function as a negative outcome, but rather as part of the learning process. Errors, technical difficulties, and iterative testing can lead to deeper understanding, provided they are accompanied by guidance and reflection. At the same time, critical perspectives on making emphasize that maker-oriented learning should not be understood only as technical production, but also as a space where participation, access and educational equity can be supported (Vossoughi et al., 2016).

Student competitions can provide a highly dynamic framework for developing such experiences. Unlike a standard school assignment, a competition introduces a specific goal, a timeframe, a challenge, an external audience, and a sense of public presentation. The literature on competition-based learning indicates that the competitive dimension, when organized pedagogically rather than strictly for grading purposes, can enhance student motivation, effort, and participation (Burguillo, 2010). At the same time, research on STEM competitions shows that student participation in such activities is associated with increased interest in scientific and technological fields, as well as the enhancement of learning goals and academic self-concept (Höffler et al., 2017; Miller et al., 2018).

In the field of vocational education, the importance of authenticity is even more pronounced. Learning acquires greater value when students recognize that what they are doing has practical utility and connects to situations beyond the school environment. Authentic and self-directed learning in vocational education has been associated with the development of professional thinking, active student engagement, and the gradual formation of an apprentice or future professional identity (de Bruijn & Leeman, 2011; Schaap et al., 2012). Therefore, participation in a competition that requires the design and creation of a tangible technological project can serve as a bridge between school knowledge, technical practice, and social application.

Despite the growing interest in experiential learning, project-based learning, and educational technologies, it remains important to investigate how students themselves experience their participation in such initiatives, especially when they take part in a national student competition for the first time. First-time participation can influence the way students perceive learning, collaboration, technology, and their personal capabilities. Particularly for vocational upper-secondary students, creating a tangible project can serve as an opportunity to strengthen self-confidence, develop technical and social skills, and reframe their overall school experience.

The present study investigates the participation of vocational upper-secondary students in a National Open Technologies Competition as an experiential learning experience. It does not focus on the technical evaluation of the final artefact, but rather on the learning process developed through the creation of a tangible technological project. Specifically, it examines how students experienced their participation in the competition, how construction and programming contributed to their learning, and how this experience affected their collaboration, interest in technology, and self-confidence.

2. THEORETICAL FRAMEWORK

2.1. Experiential learning and students' active engagement

Experiential learning is a pedagogical approach that emphasizes learning through experience, action and reflection. Rather than treating knowledge as fixed content transmitted from teacher to student, experiential learning views learning as an active process in which students observe, experiment, make decisions, encounter difficulties and reflect on their actions. In this perspective, experience alone is not sufficient; learning emerges when experience is connected with reflection and meaning-making (Kolb & Kolb, 2005).

In vocational education, experiential learning is particularly important because students are expected to connect theoretical knowledge with practical application. Vocational students often benefit from learning environments that allow them to work with concrete problems, tools, materials and authentic tasks. In such contexts, knowledge becomes meaningful when it is applied, tested and revised through practice. Active learning has been associated with increased student performance and engagement in science, technology, engineering and mathematics, as students are not passive recipients of information but active participants in the learning process (Freeman et al., 2014).

Project-based learning is closely connected with this approach. It allows students to investigate complex problems, collaborate with peers, produce a concrete outcome and connect school knowledge with real-world applications (Kokotsaki et al., 2016). Recent meta-analytic evidence has also shown that project-based learning can have a positive effect on students' academic achievement, especially when it is well structured and supported by appropriate guidance (Chen & Yang, 2019). Therefore, experiential and project-based learning provide a useful theoretical lens for examining how students learn through the creation of a tangible technological project in the context of a student competition.

In the present study, experiential learning is examined through the participation of vocational students in a National Open Technologies Competition. The focus is not placed on the technical evaluation of the final artefact, but on the learning process developed through designing, constructing, testing, collaborating, making mistakes and reflecting on the experience.

2.2. Tangible projects, making and learning through creation

The creation of tangible projects is strongly connected with constructionist approaches to learning and with the maker movement in education. In maker-oriented learning environments, students do not simply consume ready-made knowledge; they design, build, test and improve objects, prototypes or products that have a visible and material form. Making can become a powerful learning process because it enables students to externalize their ideas, transform them into concrete artefacts and improve them through feedback and experimentation (Halverson & Sheridan, 2014; Sheridan et al., 2014).

The educational value of making lies not only in the final artefact but also in the process of creation. When students work on a tangible project, they are required to plan, make choices, solve problems and revise their initial ideas. In technological projects, this process often includes programming, wiring, testing sensors, correcting errors and redesigning parts of the prototype. In this sense, mistakes are not treated simply as failures, but as opportunities for further learning. When a circuit does not work, when a sensor does not respond as expected or when the code needs correction, students are invited to investigate causes, test hypotheses and develop alternative solutions.

Research on the maker movement has shown that making activities can support creativity, problem-solving, persistence and collaboration (Papavlasopoulou et al., 2017). These characteristics are particularly relevant for vocational education, where learning is closely related to practical skills, laboratory-based work and applied forms of knowledge. Tangible projects can help students understand that technological knowledge is not abstract, but can be used to create solutions, respond to needs and produce something meaningful.

The importance of tangible student products has also been highlighted in the study by Bonareva et al. (2026), which examined how experiential learning and digital design led to the production of a student-created newspaper aimed at promoting environmental literacy. Although that study focused on a printed student product rather than a technological prototype, it is relevant to the present research because both studies examine how students learn through the creation of a tangible outcome with educational and social meaning. In both cases, learning is strengthened when students collaborate, design, produce and see the results of their work take a concrete form beyond a conventional classroom activity.

In the present study, the tangible project was developed through open technologies and Arduino-based components. However, the main interest of the study is not the technical completeness of the artefact, but the way in which the process of creating a tangible technological artefact shaped students' learning, collaboration, confidence and engagement.

2.3. Student competitions as authentic learning contexts

Student competitions can function as authentic learning contexts when they are not limited to ranking, winning or external recognition. A competition can provide students with a clear goal, a specific timeframe, a real challenge and, often, an external audience. These elements differentiate a competition from a typical classroom assignment. Students know that their work is part of a broader educational event and that their project may be presented beyond the classroom.

Competition-based learning has been associated with increased motivation and student performance, especially when competition is used as a pedagogical strategy rather than as a purely evaluative mechanism (Burguillo, 2010). In STEM-related contexts, participation in student competitions can also influence students' motivation, self-concept and interest in scientific and technological fields (Höffler et al., 2017). Similarly, research on STEM competitions has indicated that such experiences may contribute to students' interest in STEM careers, as they provide opportunities to apply knowledge in challenging and meaningful contexts (Miller et al., 2018).

Nevertheless, the pedagogical value of a student competition is not automatic. It depends on how the competition is integrated into the learning process. If the emphasis is placed only on winning or external distinction, the learning potential may be limited. On the contrary, when the competition is framed as an opportunity for inquiry, collaboration, design, experimentation and reflection, it can become a powerful context for experiential learning. In such cases, the most important outcome is not necessarily the final ranking, but the learning journey that students experience while working towards the creation of a project.

In this study, the competition is understood as an authentic framework that encouraged students to engage with a real task, work collaboratively, take roles and create a tangible technological project. The first-time participation of the students is also important, because it allows the study to explore how students experience a new type of learning challenge beyond the usual classroom routine.

2.4. Vocational education, collaboration and skills development

Vocational education is directly connected with the development of practical, technical and professional skills. However, contemporary vocational learning is not limited to technical competence. Students also need to develop collaboration, communication, critical thinking, initiative and problem-solving skills. Learning environments that involve tangible projects and authentic tasks can support these broader dimensions of student development.

Authentic and self-directed learning in vocational education has been linked to students' active engagement and to the development of professional ways of thinking (de Bruijn & Leeman, 2011). Similarly, learning processes in vocational education are strengthened when students participate in school-based and practice-oriented activities that allow them to connect knowledge with action (Schaap et al., 2012). Self-directed and self-regulated learning are also important in vocational contexts, as students are gradually expected to take greater responsibility for their learning, decisions and performance (Jossberger et al., 2010).

Collaboration is a central element in the creation of a technological project. Students need to share responsibilities, discuss ideas, coordinate actions and contribute to a common goal. Through this process, learning becomes both individual and social. Students learn from their own attempts, but also from the observations, suggestions and difficulties of their peers. The group becomes a space where knowledge is negotiated, tested and reconstructed through interaction.

Participation in a competition may also influence students' self-confidence. The experience of creating a real project, even if the final artefact is not technically perfect, can strengthen students' sense of capability and personal contribution. This is especially relevant in vocational education, where students' practical and creative abilities may not always be fully recognized through traditional forms of assessment. A tangible project can offer students an opportunity to see themselves as capable creators, problem-solvers and active participants in their learning.

Therefore, participation in a student competition and the creation of a tangible technological project can be examined as a complex pedagogical experience. It brings together experiential learning, making, collaboration, motivation, problem-solving and confidence-building. The present study is positioned within this theoretical perspective and investigates how vocational students experienced their first participation in a National Open Technologies Competition through the creation of a tangible project.

3. METHODOLOGY

3.1. Research design

This study adopted a qualitative case study design in order to explore how vocational students experienced their first participation in a National Open Technologies Competition. A case study approach was considered appropriate because the research focused on a specific group of students, a particular educational context and a bounded learning experience: the preparation and participation in a student competition through the creation of a tangible technological project.

The aim of the study was not to evaluate the technical quality of the final project or to measure learning outcomes through standardized tests. Instead, the study sought to understand the learning process from the students' perspective. More specifically, it examined how participation in the competition influenced students' engagement, collaboration, confidence, problem-solving and understanding of learning through hands-on creation.

A qualitative case study design was considered appropriate because it allows an in-depth examination of a bounded educational experience within its real-life context (Creswell & Poth, 2018; Stake, 1995; Yin, 2018).

3.2. Research context

The study was conducted in the context of students' participation in the 7th National Open Technologies Competition in Education. The participating team developed a tangible technological project using Arduino-based components. The project required students to engage with programming, electronic components, sensors, wiring, testing and prototyping. The preparation process lasted eight weeks and consisted of one three-hour meeting per week. During this period, students worked collaboratively on the design, programming, testing and completion of the tangible technological artefact.

Although the project had a technological focus, the present study does not treat it primarily as a technical artefact. Rather, the project is understood as the pedagogical context through which students engaged in experiential learning. The competition provided a real goal, a specific timeframe and a sense of public presentation, while the tangible project offered students the opportunity to connect school knowledge with practical application.

3.3. Participants

The participants were eight vocational upper-secondary students from a public vocational school in Greece. The students participated in a National Open Technologies Competition for the first time. This first-time participation was important for the study, as it allowed the research to explore how students experienced a new type of learning activity beyond the usual classroom routine.

The students worked as a team during the preparation of the project. Their involvement included practical tasks related to the construction of the prototype, observation of the programming process, testing of components, discussion of ideas and collaborative problem-solving. The small number of participants is consistent with the qualitative case study design, which aims to provide an in-depth understanding of a specific educational experience rather than statistical generalization.

3.4. Data collection

Data were collected from three main sources: semi-structured student interviews, the teacher's reflective diary and photographic material from the preparation process.

First, semi-structured interviews were conducted with the eight students. The interviews focused on students' experiences of participating in the competition, their perceptions of learning through the creation of a tangible project, the difficulties they encountered, their collaboration within the team and the ways in which the experience influenced their confidence and interest in technology. The semi-structured format allowed the researcher to follow a common set of questions while also giving students space to express personal reflections and examples from their experience.

Second, the teacher's reflective diary was used as a source of contextual and process-oriented data. The diary included observations about students' engagement, collaboration, difficulties, moments of trial and error, and changes in their participation during the preparation of the project. The reflective diary was particularly useful for documenting aspects of the learning process that may not have been fully captured in the student interviews.

Third, photographic material was used as supplementary visual documentation. The photographs documented moments from the programming and construction stages of the project, including students' interaction with Arduino-related components, the programming environment and the prototyping process. The photographs were not used as evidence of the technical completion of the final artefact, but as supporting material for understanding the hands-on and collaborative nature of the learning process.

The main methodological characteristics of the study are summarized in **Table 1**, in order to provide a clear overview of the research design, participants, duration, data sources and analytical approach.

Table 1. Overview of the research design

Element	Description
Research design	Qualitative case study
Educational context	Public vocational upper-secondary education in Greece
Competition context	First-time student participation in a National Open Technologies Competition
Participants	Eight vocational upper-secondary students
Group composition	Mostly final-year students; one first-year student; one female student
Duration	Eight weeks
Meeting structure	One three-hour meeting per week
Learning activity	Collaborative design, programming, testing and completion of a tangible Arduino-based technological project
Data sources	Semi-structured student interviews, teacher's reflective diary, photographic material
Supplementary documentation	Competition documentation confirming project completion and distinction
Data analysis	Thematic analysis
Main analytical focus	Experiential learning, collaboration, problem-solving, persistence, self-confidence and connection between school knowledge and practical application

3.5. Data analysis

The data were analysed through thematic analysis (Braun & Clarke, 2006). The analysis aimed to identify recurring patterns in the students' experiences and in the teacher's observations. The process included repeated reading of the interview material and reflective diary, initial coding of meaningful extracts, grouping of codes into broader categories and the development of final themes.

The analysis focused on themes related to experiential learning, collaboration, problem-solving, motivation, confidence and the connection between school knowledge and practical application. The photographic material was used to support the interpretation of the learning process, particularly in relation to hands-on engagement, prototyping and collaborative activity.

The final themes were developed by comparing the interview data with the teacher's reflective diary. This comparison helped strengthen the interpretation of the findings, as students' own accounts were examined alongside observations from the learning process.

3.6. Ethical considerations

The study followed basic ethical principles for research with students. Participation in the interviews was voluntary, and students were informed about the purpose of the study. Their names are not reported, and no identifying personal information is included in the analysis. Any photographic material used for publication purposes should be anonymized, with students' faces blurred or cropped where necessary.

The role of the teacher as both educator and researcher was also taken into consideration. For this reason, the analysis focused on students' experiences and reflections, while the teacher's diary was used as a complementary source of data rather than as the sole basis for interpretation.

3.7. Trustworthiness of the study

To enhance the trustworthiness of the study, data were drawn from multiple sources: student interviews, the teacher's reflective diary and photographic material. This triangulation allowed the researcher to examine the learning experience from different perspectives. The use of direct student accounts helped foreground the participants' voices, while the reflective diary provided additional insight into the development of the process over time.

As a small-scale qualitative case study, the research does not aim to produce generalizable findings for all vocational students or all student competitions. Instead, it provides an in-depth account of one specific case and offers insights into how participation in a competition and the creation of a tangible project can function as an experiential learning experience in vocational education.

4. FINDINGS

The thematic analysis of the student interviews and the teacher's reflective diary generated five main themes: initial insecurity and gradual engagement, the transition from theoretical knowledge to practical application, collaborative problem-solving, learning through trial and error, and the strengthening of self-confidence through completion and recognition. These themes are summarized in **Table 2**.

Table 2. Themes generated from the thematic analysis

Theme	Main meaning	Indicative data sources
Initial insecurity and gradual engagement	Students began with anxiety and doubts about their abilities, but gradually became more actively involved.	Teacher's reflective diary, student interviews
From theory to practical application	Programming became meaningful through its connection with physical components, sensors and automation.	Student interviews, photographic material
Collaborative problem-solving	Students supported one another and exchanged ideas when difficulties emerged.	Teacher's reflective diary, student interviews
Trial, error and persistence	Technical difficulties did not lead to withdrawal, but to repeated testing and solution-seeking.	Teacher's reflective diary
Self-confidence and recognition	The completion of the project and the distinction received in the competition strengthened students' sense of capability.	Student interviews, competition documentation

4.1. Initial insecurity and gradual engagement

During the initial phase of the activity, students appeared hesitant about participating in the competition. According to the teacher's reflective diary, forming the team was not straightforward, as several students expressed anxiety and believed that they would not be able to meet the demands of a national competition. This initial insecurity was related both to the absence of previous experience in a similar event and to students' limited confidence in their own abilities.

Participation in a National Open Technologies Competition was a new and demanding experience for the students. Although most of them had prior contact with programming, mainly through Python, the use of Arduino, sensors, wiring and automation was completely new to them. The transition from programming on a screen to making a physical system operate created uncertainty at the beginning.

However, this situation gradually changed. During the eight-week preparation period, students became more actively involved, began to take initiatives and participated more meaningfully in the process. A characteristic case recorded in the teacher's diary concerned a student who initially joined the group with strong hesitation, but later became one of the most active members of the team, almost assuming the role of an informal coordinator. This finding suggests that participation in the competition created space for students to reveal abilities that were not visible at the beginning of the activity.

4.2. From theoretical knowledge to practical application

One of the most important findings was that students experienced the activity as a transition from theoretical knowledge to practical application. Their previous knowledge of programming was not sufficient on its own, as they had to understand how code is connected with physical components, sensors, light and sound signals, and automation.

The first major technical difficulty concerned the synchronization between the program and the Arduino-based automation. Students had to understand that programming was no longer an abstract exercise, but a process that had to produce an actual response in a physical system. Through this process, technology became more understandable because it was connected with something tangible and functional.

In the interviews, students reported that creating a practical project helped them better understand what programming can do. They noted that, until then, they had mostly viewed programming theoretically, whereas through the activity they realized that it could be used to create real solutions. This experience strengthened the connection between school knowledge and its practical application.

Table 3. Transition from theory to practice

Before the activity	During the activity	Learning significance
Programming was mainly perceived as theoretical knowledge.	Students connected code with sensors, wiring and automation.	Knowledge acquired practical and functional meaning.
Arduino and automation were unfamiliar to the students.	Students experimented with components and testing procedures.	Understanding was strengthened through practice.
Students doubted their abilities.	They gradually saw the project operate.	Their self-confidence and sense of capability increased.

Figure 1 illustrates the hands-on nature of the learning process, showing students' engagement with Arduino-based components during the construction and testing phase of the tangible technological project.

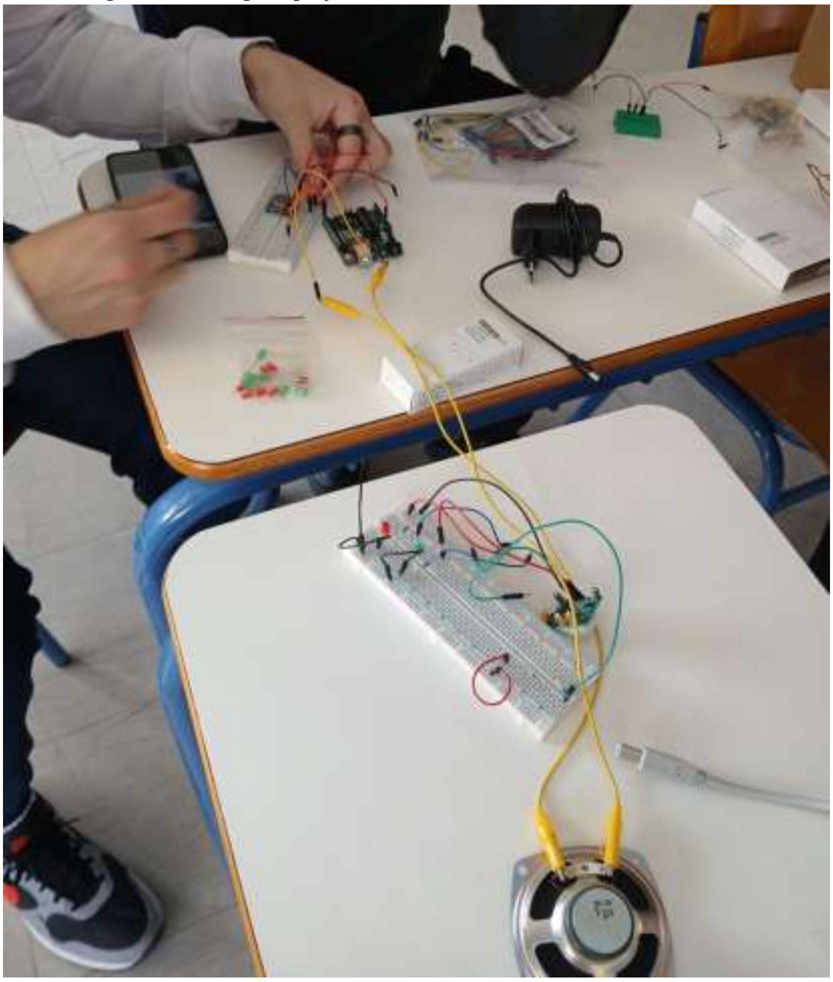

Figure 1. Arduino-based prototyping activity during the construction and testing phase. Students' faces have been anonymized to preserve confidentiality.

4.3.Collaborative problem-solving and peer support

Collaboration emerged as a central element of the learning experience. In the interviews, students reported that teamwork was positive and that no serious conflicts occurred. Instead, they described the group as a space of mutual support, where each member could contribute in a different way. The teacher's reflective diary confirmed this picture. When one student faced a difficulty or became stuck at a certain point, another student would intervene to suggest a solution, express an idea or help the process move forward. Problem-solving was therefore not an individual task, but a collective effort.

The roles within the group were not identical for all students. Some students participated more actively in technical and programming-related tasks, while others contributed through support, encouragement and coordination. This shows that the activity allowed different forms of participation. Even students who did not have the most technical role were able to contribute meaningfully to the progress of the team.

Table 4. Forms of student participation within the team

Form of participation	Description
Technical participation	Connecting components, sensors and wiring
Programming-related participation	Observing, understanding and supporting the programming process
Collaborative participation	Exchanging ideas and suggestions when difficulties emerged
Encouraging participation	Supporting the team during moments of fatigue or frustration
Coordinating participation	Taking initiatives and informally organizing the group

4.4. Learning through trial, error and persistence

The process of creating the project included repeated difficulties. There were several moments when the system did not work as expected, the application did not run properly or the automation did not respond. These difficulties created fatigue and frustration, but they did not lead students to abandon the effort.

On the contrary, students showed calmness, patience and persistence. According to the teacher's reflective diary, when something did not work, students tried again, discussed the problem with one another and searched for alternative solutions. Gradually, they were able to solve several problems by themselves, which strengthened their sense of autonomy and responsibility.

This finding is particularly important because it shows that learning did not occur only during successful moments. Instead, moments of difficulty formed an essential part of the experiential learning process. Trial, error and repetition functioned as mechanisms of understanding, persistence and collaborative problem-solving.

4.5.Self-confidence, recognition and willingness for future participation

Participation in the competition contributed significantly to the strengthening of students' self-confidence. According to the interviews, all students reported that they felt greater confidence in their abilities after completing the activity. The experience helped them realize that the knowledge they already had was not limited and that they could use it in a real project.

The completion of the project and the receipt of a distinction certificate in the competition functioned as a form of recognition of their effort. The distinction did not have only external or formal value; it also strengthened students' sense that their work had value beyond the classroom. For the final-year students, this experience was also connected with their transition towards the labour market. One student characteristically stated that the experience was "very good" and came "at the right moment," as they were finishing school and preparing to enter the world of work.

In addition, after participating in the competition, students appeared more willing to take part in other school activities. Several expressed the wish to participate again in a similar activity, while final-year students mentioned that they wished they had been encouraged earlier, so that they could have taken part in such activities in previous years as well.

Table 5. Impact of participation on students

Area of impact	Description of finding
Self-confidence	Students felt that they could respond to demanding activities.
Recognition	The distinction certificate confirmed the value of their effort.
Attitude towards technology	Students understood the practical usefulness of programming and automation.
Participation in school life	After the activity, students were more willing to participate in school initiatives.
Future orientation	The experience was connected with preparation for the labour market, especially for final-year students.

Overall, the findings indicate that participation in the competition and the creation of a tangible technological project functioned as a context for experiential learning. Students moved from initial insecurity to active participation, connected theoretical knowledge with practice, collaborated to solve problems, persisted through difficulties and strengthened their self-confidence through the completion and recognition of their work.

5. DISCUSSION

The findings of the present study indicate that the participation of vocational upper-secondary students in a National Open Technologies Competition can function as a meaningful context for experiential learning. The creation of a tangible technological project was not merely a technical activity, but a complex learning experience through which students were invited to collaborate, experiment, face difficulties and connect their knowledge with practical application.

A first important finding concerns students' transition from initial insecurity to active participation. At the beginning of the activity, several students were hesitant to participate, believing that they would not be able to meet the demands of a national competition. This insecurity is particularly significant, as it suggests that vocational students may possess knowledge and skills but may not always have the confidence to apply them in a demanding or public context. Their gradual engagement shows that authentic learning experiences can be empowering when students are given time, guidance and opportunities for meaningful participation.

A second key finding concerns the connection between theoretical knowledge and practical application. Although students had previous experience with programming, the use of Arduino, sensors, wiring and automation introduced them to a different form of knowledge. Programming was no longer an abstract activity on a screen, but was connected with a physical system that had to operate. This finding is consistent with experiential and active learning approaches, according to which knowledge becomes more meaningful when it is applied, tested and reflected upon in authentic contexts (Freeman et al., 2014; Kolb & Kolb, 2005).

This interpretation is also consistent with UNESCO-UNEVOC's understanding of experiential learning in technical and vocational education and training, where learning is connected with direct experience, active participation, reflection and feedback (UNESCO-UNEVOC, n.d.). From this perspective, the value of the competition did not lie only in students' exposure to technology, but in the fact that they first acted, experimented and faced practical challenges before reflecting on what they had learned. In addition, UNESCO's broader discussion on the futures of education emphasizes the need for learning experiences that strengthen cooperation, solidarity and the capacity of education to respond to real social challenges (UNESCO, 2021). The present findings align with this view, as students' learning was developed through collaboration, practical problem-solving and the creation of a technological project with social meaning.

The study also highlights the importance of tangible projects in the learning process. The creation of a real technological project helped students understand that technology can be used to produce solutions and not only as a school subject. This is connected with the literature on the maker movement, which emphasizes that making, experimentation and the continuous improvement of an artefact can support creativity, problem-solving and collaboration (Halverson & Sheridan, 2014; Papavlasopoulou et al., 2017; Sheridan et al., 2014). Similarly, the present study is related to the work of Bonareva et al. (2026), in which the production of a tangible student product was connected with experiential learning, digital design and the connection of school knowledge with social issues.

Another important point is that difficulties did not function as barriers, but were transformed into learning opportunities. Students encountered repeated technical difficulties, especially when the system did not operate as expected or when programming had to be synchronized with automation. However, these difficulties led to testing, redesigning, discussion and solution-seeking. In this way, failure acquired pedagogical value, as it supported persistence, calmness and collaborative problem-solving.

Collaboration was also a central element of the experience. Students did not function as isolated individuals, but as a team with different roles and forms of participation. Some students were more involved in technical or programming-related tasks, while others contributed through ideas, support, encouragement or informal coordination. This indicates that a tangible project can create space for different types of student contribution. The value of participation was not limited only to students with stronger technical confidence, but also included students who supported the team through social and organizational skills.

The strengthening of students' self-confidence is also significant. The completion of the project and the distinction received in the competition functioned as a form of recognition of their effort. This recognition had not only symbolic value, but also helped students realize that their knowledge could be applied in real and demanding contexts. For final-year students, this experience was also connected with their transition towards the labour market, as it strengthened their sense that they could respond to challenges beyond the school environment.

Overall, the present study shows that student competitions, when integrated pedagogically rather than only competitively into school life, can function as authentic learning environments. Their value is not limited to distinction or to the final artefact, but lies mainly in the process: collaboration, effort, persistence, the connection between theory and practice, and the strengthening of students' self-confidence.

6. LIMITATIONS OF THE STUDY

The present study has certain limitations that should be taken into account. First, it is a small-scale qualitative case study involving eight students from a specific educational context. Therefore, the findings cannot be generalized to all vocational students or to all student competitions.

Second, the study was mainly based on student interviews, the teacher's reflective diary and photographic material from the process. Although the use of multiple data sources strengthens the interpretation of the findings, the data remain qualitative and are connected with the experiences and perceptions of the participants.

Third, the dual role of the teacher as both coordinator of the activity and researcher constitutes another limitation. This position provides deep knowledge of the field and of the learning process, but it may also influence the way data are observed and interpreted. For this reason, the analysis was primarily based on students' voices, while the reflective diary was used as a complementary source of data.

Finally, the study did not include long-term follow-up of the students after the activity. Although the findings indicated that students became more willing to participate in school activities, it is not possible to determine with certainty the long-term impact of the experience on their learning trajectory or professional orientation.

7. CONCLUSIONS

The present study showed that the participation of vocational upper-secondary students in a National Open Technologies Competition can constitute a meaningful experiential learning experience. Through the creation of a tangible technological project, students had the opportunity to connect theoretical knowledge with practical application, collaborate, solve problems and develop greater confidence in their abilities.

The findings indicate that the learning value of the activity was not located only in the completion of the project or in the distinction received by the team, but mainly in the process that preceded it. Students' initial insecurity gradually turned into active participation, technical difficulties became opportunities for testing and learning, and collaboration strengthened both the technical and social dimensions of learning.

The study highlights the importance of student competitions as pedagogical contexts that can support experiential learning in vocational education. When competitions are organized with emphasis on process, creation, collaboration and reflection, they can offer students experiences that go beyond the limits of conventional teaching.

For vocational education, such activities are particularly important, as they help students recognize the value of their knowledge, gain experience in authentic conditions and see themselves as capable creators, collaborators and future professionals. Future research could examine similar activities with larger groups of students, in different school contexts or through longitudinal designs that explore the longer-term impact of such experiences.

8. ETHICS STATEMENT

The study followed basic ethical principles for research with students. Participation in the interviews was voluntary, and students were informed about the purpose of the study. No names or identifying personal information are reported. The school, the student team, and the specific project title are not named in order to preserve anonymity. Any photographic material used for publication purposes was anonymized, with students' faces blurred or cropped where necessary.

9. CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest related to this manuscript.

10. FUNDING STATEMENT

This research received no funding from any public, private, or non-profit organization.

11. AI ASSISTANCE STATEMENT

During the preparation of this manuscript, artificial intelligence tools, specifically ChatGPT and Gemini, were used solely for language support, linguistic transfer from the authors' native language, and improvement of wording. The authors reviewed, edited, and take full responsibility for the final content of the manuscript.

REFERENCES

1) Bonareva, V., Patropoulos, A., Pantermali, M., & Daskali, O. (2026). From experiential learning and digital design to printed action: Promoting environmental literacy through a student-produced newspaper. *Science Activities*. Advance online publication. https://doi.org/10.1080/00368121.2026.2658581
2) Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa
3) Burguillo, J. C. (2010). Using game theory and competition-based learning to stimulate student motivation and performance. *Computers & Education, 55*(2), 566–575. https://doi.org/10.1016/j.compedu.2010.02.018
4) Chen, C.-H., & Yang, Y.-C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. *Educational Research Review, 26*, 71–81. https://doi.org/10.1016/j.edurev.2018.11.001
5) Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE.
6) de Bruijn, E., & Leeman, Y. (2011). Authentic and self-directed learning in vocational education: Challenges to vocational educators. *Teaching and Teacher Education, 27*(4), 694–702. https://doi.org/10.1016/j.tate.2010.11.007
7) Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences, 111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111
8) Halverson, E. R., & Sheridan, K. (2014). The maker movement in education. *Harvard Educational Review, 84*(4), 495–504. https://doi.org/10.17763/haer.84.4.34j1g68140382063
9) Höffler, T. N., Bonin, V., & Parchmann, I. (2017). Science vs. sports: Motivation and self-concepts of participants in different school competitions. *International Journal of Science and Mathematics Education, 15*, 817–836. https://doi.org/10.1007/s10763-016-9717-y
10) Jossberger, H., Brand-Gruwel, S., Boshuizen, H. P. A., & van de Wiel, M. W. J. (2010). The challenge of self-directed and self-regulated learning in vocational education: A theoretical analysis and synthesis of requirements. *Journal of Vocational Education & Training, 62*(4), 415–440. https://doi.org/10.1080/13636820.2010.523479
11) Kolb, A. Y., & Kolb, D. A. (2005). Learning styles and learning spaces: Enhancing experiential learning in higher education. *Academy of Management Learning & Education, 4*(2), 193–212. https://doi.org/10.5465/amle.2005.17268566
12) Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools, 19*(3), 267–277. https://doi.org/10.1177/1365480216659733
13) Miller, K., Sonnert, G., & Sadler, P. (2018). The influence of students' participation in STEM competitions on their interest in STEM careers. *International Journal of Science Education, Part B: Communication and Public Engagement, 8*(2), 95–114. https://doi.org/10.1080/21548455.2017.1397298

14) Papavlasopoulou, S., Giannakos, M. N., & Jaccheri, L. (2017). Empirical studies on the maker movement, a promising approach to learning: A literature review. *Entertainment Computing*, *18*, 57–78. https://doi.org/10.1016/j.entcom.2016.09.002
15) Schaap, H., Baartman, L. K. J., & de Bruijn, E. (2012). Students' learning processes during school-based learning and workplace learning in vocational education: A review. *Vocations and Learning*, *5*, 99–117. https://doi.org/10.1007/s12186-011-9069-2
16) Sheridan, K. M., Halverson, E. R., Litts, B. K., Brahms, L., Jacobs-Priebe, L., & Owens, T. (2014). Learning in the making: A comparative case study of three makerspaces. *Harvard Educational Review*, *84*(4), 505–531. https://doi.org/10.17763/haer.84.4.brr34733723j648u
17) Stake, R. E. (1995). *The art of case study research*. SAGE.
18) UNESCO. (2021). *Reimagining our futures together: A new social contract for education*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000379707
19) UNESCO-UNEVOC. (n.d.). *TVETipedia glossary: Experiential learning*. UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training. Retrieved June 23, 2026, from https://connect.unevoc.unesco.org/home/TVETipedia+Glossary/show=term/term=experiential+learning
20) Vossoughi, S., Hooper, P. K., & Escudé, M. (2016). Making through the lens of culture and power: Toward transformative visions for educational equity. *Harvard Educational Review*, *86*(2), 206–232. https://doi.org/10.17763/0017-8055.86.2.206
21) Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE.

Corresponding Author: Victoria Bonareva