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Novelette, a Usable Visual Storytelling Digital Learning Environment

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ABSTRACT Educational digital storytelling is widely recognised as a powerful approach in developing literary skills, experiencing problem-solving and computational thinking, information and knowledge visualisation, building creativity and divergent thinking supported by technological solutions. However, educators feel that they miss opportunities, skills, and tools to support pupils developing creativity. Hence, we proposed a digital learning environment, named *Novelette*, to support both educators and learners in performing visual storytelling by scaffolding them in inventing and authoring stories. The main novelty of our approach lies in embedding literary artifices widely explored in learning settings into a digital learning environment, such as the opportunity to continue someone else's story and the suggestion mechanism to explore analogies or synonyms starting from a word of interest. *Novelette* has been ideated not only as a learning environment *for* educators, but *with* educators, as it results from a user-centered and participatory design methodology to involve them in the entire design and development process actively. This paper focuses on the assessment of *Novelette* usability according to both educators and pupils. As a conclusive step of the co-design approach, developers tested the resulting usability according to educators in a controlled environment. Moreover, it reports usability according to learners in real settings at school. Results demonstrate that *Novelette* is considered usable by both target groups, and it is perceived as a powerful approach in developing creativity both according to quantitative insight offered by the System Usability Scale, a.k.a., SUS, and qualitative interpretations enabled with direct observations and structured after scenario questionnaires. We can conclude that *Novelette* is a pleasant and usable tool to invent and author stories and seems to be a promising approach to develop creativity.

INDEX TERMS Collaborative design, digital learning environment, digital storytelling, education, usability.

I. INTRODUCTION

Storytelling represents the skill of inventing and authoring stories, behaving as a simple but powerful method to share experiences and convey knowledge [1]. It empowers learning practices, enables knowledge sharing and communication, critical thinking, and technical skills development [2].

Digital storytelling is a storytelling practice in which users are supported by technological solutions [3], such as authoring interfaces or digital learning environments. As a result, besides authoring stories by traditional means, such as paper and pencils, users can experience visual storytelling by relying on digital media, including images and text [3]. It has become increasingly popular in many fields, such as human health [4], narrative therapy [5], media [6], entertainment [7], tourism [8], data visualisation [1] and education [9].

Educational digital storytelling has a robust tradition that relies on Bruner's research concerning the role of narratives as an opportunity for learners to share knowledge [10]. It is perceived as a powerful technology-enhanced learning approach [11], widely adopted at each education level, from primary to secondary [11]. It has also been investigated in a broad range of educational domains, from religion [12] to healthcare [13], from anti-bullying [14] to first aid

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intervention [15], social issues [16], computational thinking [17], science learning [18], social science [19], economy, and cultural heritage [20], demonstrating that it may be used to introduce and discuss any topic of interest.

Storytelling is metaphorically defined as *thinking without a bannister* [21], underlying the strict relationship between storytelling and creativity. It may lead to think out of the box, reason differently by using imagination and intuition, and develop critical and divergent thinking, the thought approach used to develop creative ideas or not conventional solutions by augmenting problem-solving skills. Storytelling enables learners to develop their literacy skills [2], [22]–[25], creativity [26], digital and technological skills, and the ability to communicate through images [27] clearly and effectively [28] to ensure story memorability [29], experience computational thinking and problem-solving skills, including synthesising, analysing, evaluating, and presenting information [27] by exploiting narratives [30].

Narratives are scaffolding resources, such as templates, that behave as a starting point to invent and tell stories [30]. They concern how authors tell a story and include both narrative artifices and the art of visually presenting any topic of interest [1]. In this direction, the Italian writer Gianni Rodari defined techniques, methods, literary and narrative arrangements to let children invent and tell stories, and he collected them in his masterpiece entitled *Grammar of Fantasy* [23]. Among others, he described the art of playing on words (referred to as the *suggestion mechanism* in the remaining article) and the possibility to continue someone else's story (referred to as the *incipit mechanism* in the following).

All the contributions mentioned above prove that narratives and principles for empowering storytelling skills are widely explored in education. However, according to a survey conducted in 2020, educators feel that there are not enough opportunities for developing creativity at school [31], and the situation does not seem to change much in 10 years, as already in 2010, teachers claimed the need more for support and training to help pupils fully develop their creative potentiality [32]. Creativity potentially lies in everyone, but it is crucial to provide learners with stimuli and a favourable context to emerge these skills. Thus, educators and children need to be supported by digital solutions to improve and develop their creativity.

To mitigate the lack of tools to support learners in improving their creativity through digital storytelling, we proposed *Novelette* [33], [34], a free and open-source digital learning environment to invent and author visual stories. As a digital storytelling authoring interface, *Novelette* supports pupils in creating, refining, and rendering stories containing textual and graphical components. As its main novelty, *Novelette* embeds narrative artifices proposed by Gianni Rodari to scaffold pupils in inventing their stories. In particular, *Novelette* embeds the suggestion mechanism to guide pupils in playing on words by iteratively exploring synonyms and analogies and enabling pupils to continue someone else's story through the incipit mechanism. In addition to being classified as a storytelling authoring interface, *Novelette* is a digital learning environment that scaffolds educators in managing groups.

This article focuses on the *usability* assessment of *Novelette*. According to the ISO 9241 standard definition, usability is defined as *"The extent to which targeted users can use a product to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use"* [35]. Usability is recognised as a crucial factor when evaluating educational technology in schools as it can affect the teaching-learning process; for example, the learners' attitudes toward the software could be influenced by usability issues that were not carefully taken into account during the evaluation [36]. A poorly designed interface may cause learners to feel lost, confused, or frustrated, which will hinder effective learning and information retention [37]. Including end-users in design phases and detecting usability problems at an early stage can lead to adequate solutions and effective learning systems [36] as a lack of usability may hinder pupils' learning [36]–[38].

To identify learners' needs and take care of learning requirements, *Novelette* results from a collaborative design approach in which educators have been actively involved in proposing features and revising the final prototype. As a result, *Novelette* has been designed not only *for* education, but also *with* educators. As *Novelette* aims to support educators and pupils in performing educational digital storytelling, collecting opinions from both target groups is crucial.

The paper is structured as follows: Section II defines the background of the article reporting Rodari's literary artifices embedded in *Novelette* and overviews similar toolkits supporting digital storytelling; Section III summarising *Novelette* features fully described in previous contributions [33], [34], its operating mechanism, and a guided use case to demonstrate how it can be used to perform educational digital storytelling in presence at school; Section IV reports the collaborative design of *Novelette* combining user-centered and participatory phases by actively involving educators; Section V reports the *Novelette* usability evaluation. First, the usability evaluation was performed by a group of 11 educators who tested *Novelette* in a controlled environment as the consensus of the collaborative design approach. Second, the usability assessment was performed in a formal setting, at school, by involving 49 pupils attending an Italian primary school. According to the usability rate measured by the System Usability Scale (SUS), *Novelette* achieved a *good usability* score. While pupils stated that they felt inspired by *Novelette* and supported in developing their creativity, educators appreciated the safe environment offered by *Novelette*. Section VI summarises main limitations of the proposed approach. Finally, Section VII concludes with final remarks and future directions.

II. BACKGROUND

This section summarises the theoretical and technological background of the work described in this article. First, it overviews literary artifices defined by Gianni Rodari

representing standard approaches proposed in Italian literature for children to encourage pupils to invent and tell stories. Second, it reports toolkits proposed in the literature to support children in performing digital storytelling.

A. LITERARY ARTIFICES BY GIANNI RODARI

Gianni Rodari (1920-1980) is an Italian writer, considered worldwide as a master in children's literature, and his contributions are translated into more than 50 languages. His books are an amazing exercise of literary creativity, an attempt to nonsense plots, and a sophisticated exploration of the many possibilities of the Italian language. He encourages storytellers to use imagination to create imaginary scenarios and trigger metaphorical consequences.

His masterpiece entitled ''Grammar of Fantasy'' [23] is a theoretical essay on the art of writing stories. It provides educators and children with artifices, techniques, exercises, and approaches to author stories.

Among the proposed narrative artifices, this article focuses on the suggestion and the incipit mechanisms as they represent some of the best-known approaches to invent stories.

1) SUGGESTION

The suggestion mechanism represents any technique to be inspired and overcome the blank page syndrome. To introduce this literary artifice, Rodari uses the metaphor of ''*throwing a stone in the pond*'': when the stone touches the surface of the water, many concentric waves start. The human brain behaves in the same way when a word comes to mind by recalling mental images, associations, metaphors, personal experiences, and feelings. Rodari suggests thinking about a small set of words, a single word in the simplest case, and exploring synonyms and analogies by playing on terms. The process generates a chain of words that lead narrators to recall images that may inspire stories.

2) INCIPIT

The incipit mechanism represents the possibility of continuing someone else's story. Rodari uses the story of Pinocchio to introduce this concept by challenging readers to think about ''*what happened to Pinocchio when he became a child?*''. While the Pinocchio tale ends with the transformation of Pinocchio into a real child, Rodari uses it as a starting point for another story. In this way, basic narrative components, such as characters, time, and place, may take unexpected paths and lead to a surprising development. According to these literary artifices, pupils may be provided with an incomplete story to continue through their creativity.

B. OTHER DIGITAL STORYTELLING TOOLS

Several digital storytelling platforms have been proposed to create media or data stories, such as Tableau-Stories [39], iStory [40], and Gravity [41]. Although journalists and media curators widely adopt these tools, they cannot be easily adopted as educational digital storytelling platforms because they lack features considered crucial in learning settings, such as support at the class level, group management, and literary support as defined by Rodari.

Table 1 provides an overview of the related work supporting educational digital storytelling, implementing group management features, and/or literary artifices as defined by Rodari to support the story invention phase. Tools are classified as *digital storytelling editors* if they are provided with story authoring and publishing mechanisms. *Class management*, shortened by Mgmt., feature represents support at the class level, group management, and supervision from the educator's perspective. *Incipit* and *Suggestion* represent any approach to embed Rodari-style artifices in the digital storytelling platform.

TABLE 1. Digital storytelling tools comparison.

Tool	Year	Digital Storytelling editor	Class mgnt.	Incipit	Suggestion
Fabula	2017	-	-	✓	✓
Communics	2020	✓	-	-	✓
Wakelet	2019	✓	✓	-	-
UTellStory	2020	✓	✓	-	-
StoryJumper	2020	✓	✓	-	-
Storyboard That	2020	✓	✓	-	-
Pixton	2020	✓	✓	-	-
Storybird	2020	✓	✓	-	-
Comic Life	2020	✓	✓	-	-
Novelette	2020	✓	✓	✓	✓

1) INCIPIT AND SUGGESTIONS

Fabula[1] scaffolds professional writers to create stories supported by narrative suggestions, such as synonyms, rhymes, predefined sentences, and the incipit mechanism interpreted as proposed sentences pertinent to the user typed words. Fabula enables the creation of stories in a written form without any media support. Thus, it cannot be classified as a digital storytelling editor.

Communics [42] is a web-based digital tool designed to support the creation of comics. Communics provides users with a library of suggestions implemented as predefined sentences to overcome the ''blank page syndrome''.

Even if they represent a step forward in Rodari-style storytelling support, they do not meet the class management requirement.

2) CLASS MANAGEMENT

By focusing on platforms that implement both the storytelling creator and the class management features, *Wakelet* [43] and *UTellStory* [44] are online platforms which enable the possibility of exporting authored stories and embedding them into any other website. *Storyboard That* [45] and *Pixton* [46] enable the creation of comic strips. *Storybird* [47] and *Comic Life* [48] are commercial tools, while *StoryJumper* returns a paid book by posing a strong limitation on the use of the tool. They represent significant contributions to educational

[1] https://www.scribis.it/fabula/index.html
unpublished tool, available since 2017 (Internet Archive WayBackMachine).

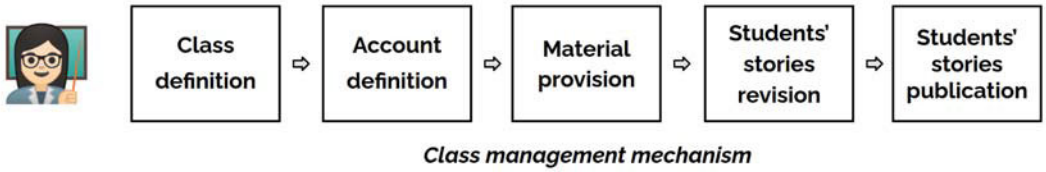

FIGURE 1. Class management workflow.

digital storytelling environments, but they do not implement any literary artifice to support pupils inventing stories.

Novelette fills this gap as a digital learning environment to scaffold educational digital storytelling with Rodari-style support. In other words, it is a digital storytelling creator enhanced by the class management feature and embedding the incipit and the suggestion mechanisms to support pupils in inventing stories.

III. NOVELETTE

Novelette is a digital learning environment that supports educators and learners in inventing and authoring linear stories. It provides target users with an editor interface to perform digital storytelling and features to support learners in inventing stories by thinking out of the box and improving their creativity. The inventing step is enabled by embedding the incipit and the suggestion mechanisms in *Novelette*.

Novelette is based on *student* and *teacher* roles. While learners play the storyteller role as they can invent and tell any story of interest, teachers can organise classes, supervise created stories, and publish them.

This section overviews supported features and reports the workflow performed by the primary school involved in the evaluation as a guided use case to show how *Novelette* can be used to perform educational digital storytelling in a formal setting, such as at school, during an in-presence lesson.

A. FEATURES

This section describes the class management and digital storytelling editor features of *Novelette* for inventing and creating stories supported by Rodari's style mechanisms.

1) CLASS MANAGEMENT FEATURES

Users who play the teacher's role are provided with a managerial dashboard (visible in Fig. 2) which enables the class management features summarised in Fig. 1.

First, teachers must create classes to organise learners. All created classes are visible at the top of the dashboard in Fig. 2. They may create an arbitrary number of classes that can model real classes, merge two or more classes, or split learners attending a class into groups. For each class created in *Novelette*, teachers can register learners' accounts to allow them to access the `creator` component, which is the story editor interface. Learners' accounts can be managed using the *account* tab in Fig. 2. *Novelette* supports teachers in automatically generating a set of anonymous accounts to overcome privacy issues with minors.

Educators can revise learners' stories and publish them to make stories visible outside of the class sandbox. While each learner has only access to the authored stories, teachers have visibility at the class level. All the stories are collected in the *Stories* tab as shown in Fig. 2. Educators can perform basic story manipulation, such as rendering a saved story using the play button or removing it using the trash bin icon.

Novelette also simplifies the mechanism of material sharing among teachers and learners. It represents an opportunity to avoid asking pupils to look for images of interest on the Web without a supervised approach. Furthermore, it supports educators in distributing material with the entire class at once via an inner sharing mechanism. For each class, educators can upload the suggested images using the *Images* tab visible in Fig. 2. Students can access both images shared by educators and default images, which are part of the internal picture library of *Novelette*, via the `creator` interface.

2) THE INCIPIT MECHANISM

Educators may provide learners with incipits as templates. Teachers can introduce a topic by providing learners with the initiation of a story, and learners are encouraged to continue the story starting from this premise. Alternatively, teachers can bind the story initiation and its ending and ask learners to interpose their stories by satisfying these constraints. For instance, it can be used to narrate different versions of the same story where there are two or more events that everyone knows, and learners have a different point of view of what happened in the meanwhile.

Fig. 3 shows the *Novelette* creator interface when learners start with an educator incipit. In this case, teachers have provided their classes with a Rodari's tale "*The Land starting with S*" that narrates about an island where all the object names start with S, and this feature completely alters object properties. For instance, the *s*-harpener can stretch pencils instead of shortening them, or the cannon becomes an *s*-cannon and, instead of attacking enemies, brings peace to all. It is worth noting that in the Italian language, the prefix *s* is usually used to define the opposite of a term. For instance, given the term *legare*, literally *to tie*, its opposite is created by putting an *s* in front of it. Consequently, *s-legare* means *to untie*. Thus, the prefix *s* in Italian behaves as *in, un, im, ir, il, over* or *dis* prefixes in English. However, just saying that pupils have to tell stories about the opposite of a term is

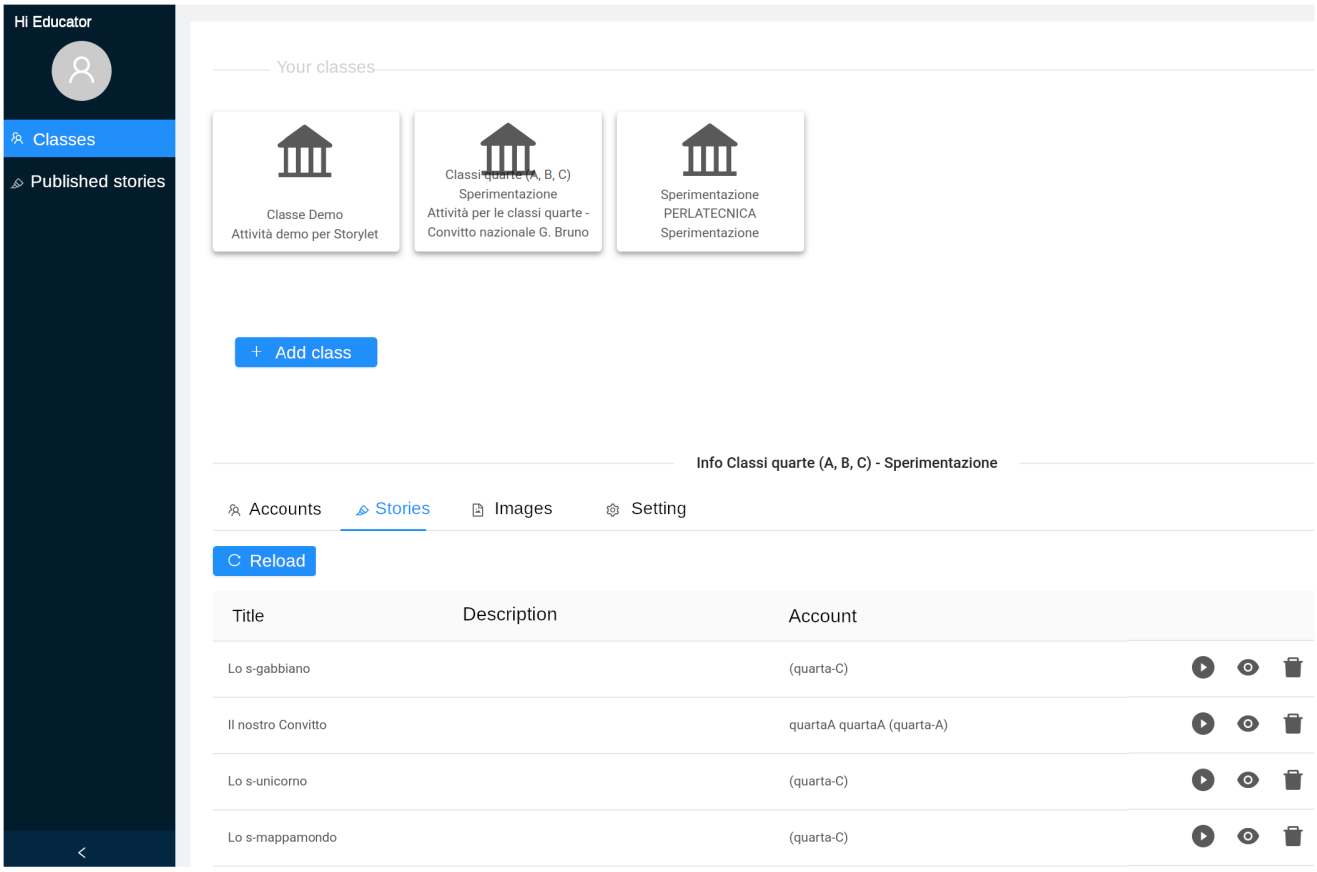

FIGURE 2. Educators' managerial dashboard.

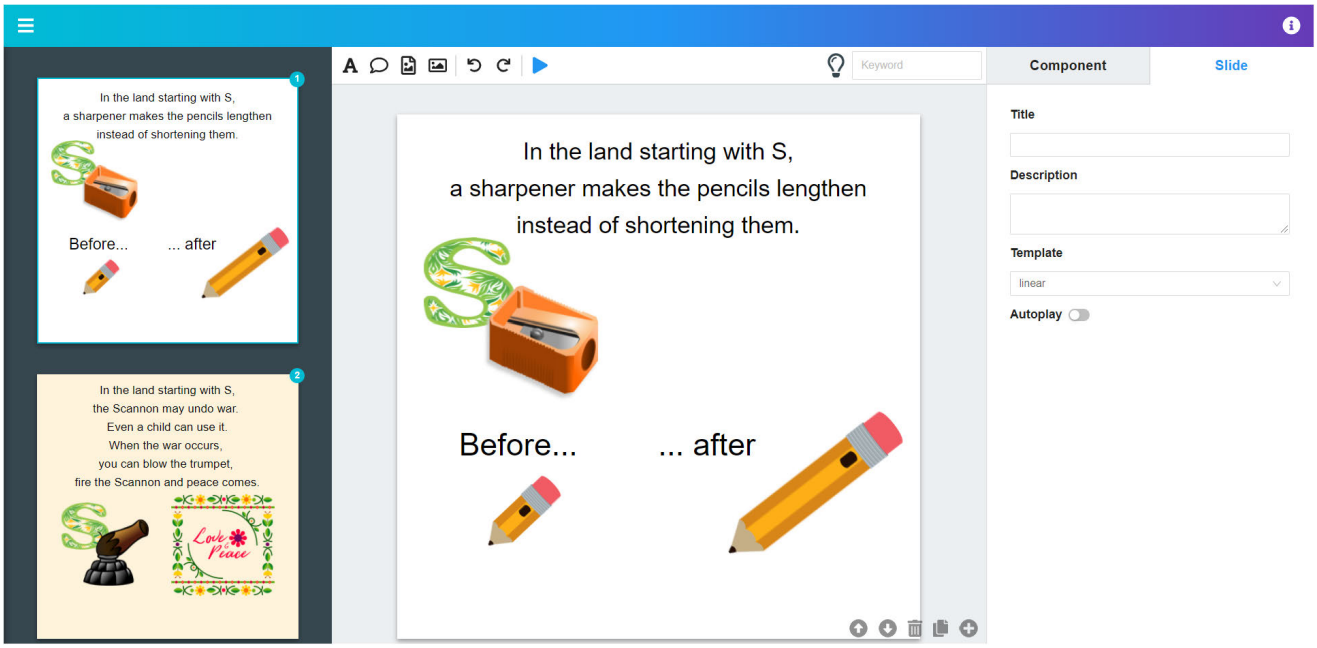

FIGURE 3. *Novelette* creator interface.

restrictive. *S* as a prefix should be perceived as an opportunity to make ordinary objects able to behave in a completely different manner. It is a type of superpower. Thus, pupils are invited to think about an ordinary object and imagine how the prefix *s* can completely change one of its features, leading to an unexpected and surprising development.

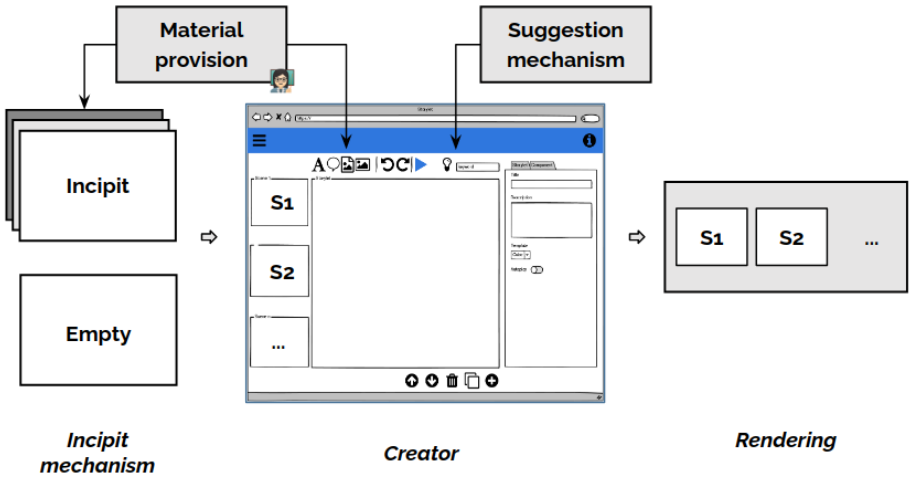

FIGURE 4. Workflow to create stories on the student side.

3) DIGITAL STORYTELLING EDITOR

Users who play the student role can author stories according to the workflow described in Fig. 4. Once authenticated, learners have to select one of the available templates. Some of them are default templates proposed by the platform, for example, the empty template, while others represent the educators' defined incipits. Once the starting point is chosen, learners access the `Novelette creator` component, that is the creator interface to invent and author stories, whose interface is visible in Fig. 3.

The *Novelette* creator component offers a clear and concise interface where icons and tooltips clarify all the performable actions to meet intuitiveness requirements. The massive usage of icons partially overcomes the internationalisation issue, guarantees inclusiveness, and poses no age limit by offering an interface usable by pupils.

Stories are composed of a sequence of scenes, and each scene can contain media content such as text, characters, and a single background. As a story editor, the *Novelette* creator provides access to a library of images, including characters and backgrounds. Educators can share images with the entire class, as previously described, to enhance the default library of images. Finally, learners can freely upload images from local storage, such as images drawn by themselves. In this way, *Novelette* behaves as a learning system capable of integrating traditional learning mechanisms, such as pencil and paper artifacts, with technology-enhanced learning strategies [37].

The possibility of importing images of any style, such as images downloaded by the Internet, drawn or authored by students, reinforces the absence of constraints of the *Novelette* applicability. Learners can upload charts and create media or data stories, pupils' authored images to personalise the story style, photos, or web content to narrate tales, deeds, or any topic of interest. Once selected images, *Novelette* supports learners in performing basic manipulation, such as changing image size, rotation, orientation, and mirroring.

Novelette offers a forgiving mechanism (a.k.a. undo) to erase errors. The recovery operation is a crucial feature for a graphical interface, above all in learning systems, as it enables explorative learning without fear [49] with the possibility of revisiting work under definition [50].

Once learners have invented and created their stories, they can visualise them by selecting a rendering template that determines the visualisation approach in the `Novelette viewer` component. For instance, students can choose a linear layout to show the scenes in sequence. Alternatively, they can opt for a circular layout, where scenes are presented on a wheel, or a cube, where they are placed on cube faces. Some of the rendering templates pose a constraint on the number of scenes that can be visualised; for example, the cube uses at most six scenes. Authored stories can be exported as HTML components and embedded in any website.

4) SUGGESTION MECHANISM

If users experience blank page syndrome, *Novelette* offers a suggestion mechanism of analogies, synonyms, and rhymes based on a user-defined word. Starting from a word of interest, *Novelette* groups synonyms by senses. For example, given the `heart` word, it can be interpreted as `love` with affection as synonym, `organ` with cardiac organ as synonym, `centre` with nutshell and core as synonyms, or as `card seed`.

In addition to senses and synonyms, users can also navigate analogies and associations, that are words, adjectives, and verbs related to the word of interest due to their co-occurrence in idiomatic expressions, spoken language, or literature. For instance, a dragon is a fictional animal, usually a character in a magician tale where wizards also appear. Therefore, *animals, magicians*, and *wizards* are analogous to *dragon*. Suggestions should not be merely considered as an opportunity

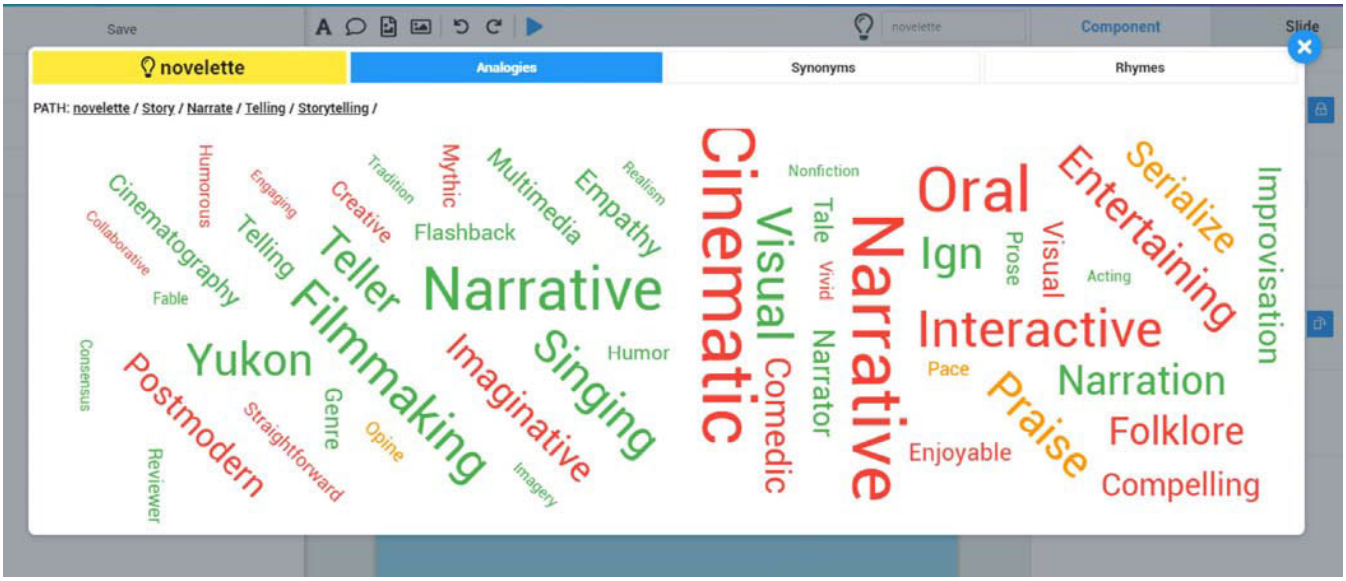

FIGURE 5. The suggestion mechanism in *Novelette*.

to avoid repetitions but should inspire writers by letting them play on words and exploring associations.

According to Rodari, analogies should enable narrators to create a chain of words and rapidly follow thoughts by moving from one word to another. Thus, *Novelette* offers navigable analogies where users can move from one word to another until they feel inspired by the obtained word chain.

Novelette visualises senses and analogies via word clouds, widely explored in the literature to facilitate storytelling [51]. As an example, Fig. 5 reports analogies *Storytelling* where storytelling is the last word of the path starting from `Novelette` and corresponding to `Novelette > Story > Narrate > Telling > Storytelling`. The word size reflects the association weight, while colours distinguish different parts of the speech. To generate suggestions, *Novelette* relies on external services. In particular, it exploits BabelNet to look for synonyms, WordAssociations[2] for analogies, and RhymeBrain[3] for rhymes.

BabelNet [52] is a huge multilingual semantic network that integrates lexicographic and encyclopaedic knowledge from WordNet and Wikipedia. A semantic network is a knowledge base that represents the semantic relations between concepts in a network. It is a directed graph consisting of vertices, which represent concepts and edges, that represent semantic relations between concepts [53]. Semantic networks, also known as knowledge graphs, are crucial for knowledge management and information retrieval [54]. However, their query languages are difficult for lay users, such as pupils [55], [56]. Knowledge graph querying mechanisms should mask the underlying complexities to allow users without technical skills to easily query languages to exploit semantic network content. Thanks to navigable word clouds, learners, regardless of their age and technical skills, can implicitly query huge semantic networks and take advantage of them during learning phases without being forced to develop additional expertise in data modelling and query languages.

B. TECHNICAL DETAILS

Novelette, freely available online with an open source license,[4] realises portability as it is a web-based platform composed of four independent ReactJs web applications. Each application is implemented as a modular and reusable component that meets the modularity requirement. The back-end is implemented in PHP, and a WordPress plugin manages data and accounts. The back-end provides access to resources using RESTful services to populate the user interface through a profile access control.

Internalisation is achieved through application settings and a third-party library that dynamically loads the language resources according to the system configuration (i.e., the language set by the user). *Novelette* is currently available in English and Italian but it is designed to be easily extended to other languages, thanks to its modular implementation. We are already working to extend the supported languages, such as French, Dutch, Spanish, and German, to encourage European partners to join our project.

C. A GUIDED TUTORIAL

A previous article of ours [33] details *Novelette* architecture and its operative workflow by describing a collection

[2]WordAssociations: `https://wordassociations.net/`
[3]RhymeBrain: `https://rhymebrain.com`

[4]*Novelette* homepage: `http://www.isislab.it:19984/en/home-page-2`.
Novelette source code: `https://github.com/routetopa/storylet`

of use cases to make evident that *Novelette* can be used to author stories ranging from tales to data- and media-stories. It demonstrates that *Novelette* can be used to create stories different in content, style, layout, and target audience.

This section focuses on educational use cases and describes how *Novelette* can be used in real settings, e.g., at school, to allow pupils to invent and author stories. It reports the mechanism adopted by an Italian primary school in the Campania Region, *Convitto Nazionale Giordano Bruno*, where *Novelette* has been exploited to perform digital storytelling in person.

As described in Fig. 1, educators have to create a *Novelette* class for each involved group by choosing the granularity of the group management. As this use case involved three real classes, educators could create a *Novelette* class for each real class, split classes into groups or create a high-level class. They opted for creating a single *Novelette* class, named *Forth classes*, so all the involved teachers could check students' work at once by accessing the same educator account.

Each class in the *Convitto Nazionale Giordano Bruno* is equipped with a virtual board and a laptop. Consequently, teachers opted for asking learners to use *Novelette* either one by one or collaboratively. According to this setting, teachers created three accounts, one for each class by, first, auto-generating three accounts and, then, re-naming them *forth-class A*, *forth-class B* and *forth-class C*. They also customised passwords to be easily recalled.

During the task of exploiting the incipit mechanism, the moderator started from the idea of *The Land starting with S* reported in Fig. 3 and proposed a story of a *s*-camera making faces instead of taking pictures, as represented in Fig. 6.

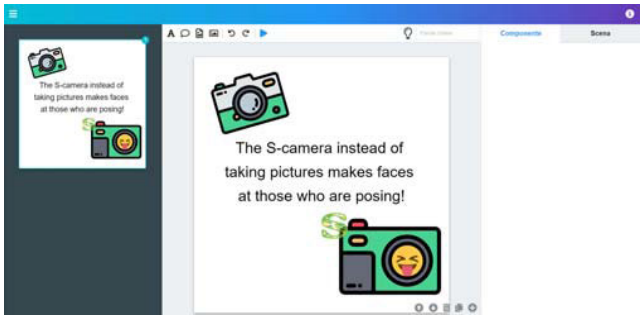

FIGURE 6. ***Novelette*** **creator to invent and tell stories.**

To demonstrate how to author the first story by *Novelette*, educators played the storyteller's role. They started from the empty template. The main character of the story is a camera. Thus, educators looked for a camera representation in the library of characters. Then, as the story requires to attach an *s* as the prefix to every object, they selected the character representing the letter s. This character has been uploaded by the educator's side to suggest images to storytellers. Thus, it appears in the character library as a pre-defined character. Once selected characters, they can be posed on the scene layout. Educators moved them to the bottom right corner. Finally, they added a textual description to present the authored object, stating that it is an s-camera that makes faces at those posing instead of taking pictures. Storytellers can change font size, text formatting, positioning, to obtain a scene similar to the one reported in Fig. 6. Once saved, the storyteller can render the resulting story. Finally, it can be downloaded as an HTML component and embedded in any blog, such as the school website.

In doing that, learners experienced the feature to select images, add textual content, apply basic manipulation to images (e.g., resize and positioning) and text (e.g., change colour, formatting, positioning), and render stories by *Novelette*.

IV. DESIGN APPROACH

The role of end-users in designing and implementing user interfaces is at the basis of many Human-Computer Interaction (HCI) methodologies [57]. Researchers argue and motivate end-users to play a crucial role in developing technological solutions [57]. Based on the available literature, end-users are usually only involved in the testing phase [45], [46], [58]. However, during the evolution of HCI methodologies, the end-user role became increasingly active to such an extent that they are involved not only in the evaluation phase but also in the entire design process.

In designing technology-enhanced learning systems, involving educators in the collaborative design would lead to selecting goals and objectives that are crucial for the learning settings and address concrete pupils' needs [59]. Moreover, their involvement in designing tools and technology-based learning solutions leads them to enhance the process of placing technology, content, and pedagogy together [60].

When an organisation and a defined group of end-users work together to design and refine a product, co-creation takes place [61]. In this approach, there are different HCI design methodologies involving end-users that can be applied, such as user-centered and participatory design [57]. While the *user-centered design* approach [62] relies on designers focusing on users' needs without any actual involvement of real end users [57], in the *participatory design* approach [63], users play an active role by contributing to the design and development processes proposing functionalities and rising design issues [57].

Novelette has been designed and developed by combining user-centered and participatory design to address educators' needs and actively involve them in proposing and reviewing supported features. At the beginning of the *Novelette* project, developers identified educators' and learners' needs regarding creativity support, expected features in a digital storytelling platform, and interface requirements mainly by looking at the state-of-the-art. Consequently, the requirement elicitation phase of *Novelette* took place as a user-centered design approach. Once the project goals are identified, the initial requirements are elicited, and the proposed interface of *Novelette* is prototyped, developers actively involved interested educators in testing the platform, verifying in first person the ease of use, and suggesting either integration or

modifications to supported features. *Novelette* has been iteratively refined according to educators' feedback by following the action research process, widely explored in the literature for improving educational practice [64]. This process involves a plan, action, evaluation, and reflection to gather evidence to implement changes in practices [65]. Similarly, during the *Novelette* design, developers plan and implement functionalities according to the feedback collected during the previous round, end-users were asked to evaluate the resulting prototype, and reflections were collected to revise the tool features during the following round. We further analyse each phase.

A. REQUIREMENTS ELICITATION PHASE - USER-CENTERED DESIGN

Novelette supports educators and learners in inventing and authoring stories by improving their creativity and posing no limit to their imagination. Goals, requirements, features, user interface, and interaction models have been proposed by taking into account the state-of-the-art, collecting educators' needs, and analysing educational digital storytelling tools.

Digital storytelling platforms usually support users in presenting their stories. *Novelette* also aims to scaffold learners in inventing them by embedding techniques proposed by Rodari. The introduction of narrative artifices in a digital learning environment represents the most noticeable novelty of our proposal. It aims to provide learners with a digital tool to develop their creativity and experience divergent thinking by combining linguistic and literary artifices borrowed from educational literature.

This resulted in the proposal of the *Novelette* project, a digital learning environment to support educators and learners in inventing and authoring stories, as described in Section III. The proposed approach is general enough to be adopted in a wide range of educational subjects and contexts, from the literature and classic tales to historical events and war undertakings, from theorem demonstrations to project presentations.

B. ACCEPTANCE PHASE - PARTICIPATORY DESIGN

In December 2019, we introduced the *Novelette* project to an audience of more than 100 schools. Participants voluntarily joined the 1-hour presentation session in person. This event was part of a series of project demonstrations to schools and educators organised by an Italian educational company, BIMED,[5] as an opportunity to bring together developers, technicians, research groups, and companies interested in proposing solutions for the educational field and schools as end-users. We considered this public event the user acceptance phase and collected a list of interested school representatives participating in periodic meetings with our research group and proposing *Novelette* at their schools. Since the planned meetings were thought to be in person, we mainly collected participation from local partners.

We performed a hands-on session during the same event where every interested educator was encouraged to think about a use case that might take advantage of *Novelette*. There were 17 participants, mainly professors and a school principal. The hands-on session took 2 hours of work and a free session of question-answering, organised as follows:

1) **scenario definition** in the introductory phase. A *scenario* represents a methodological approach to report a use case, and it is composed of the target age range, covered theme(s), educational objectives, a brief overview of the proposal, its operating mechanism to realise the idea, the involved subject(s), and the available technological devices. Scenarios as thematic proposals aim to define and coordinate an interdisciplinary approach by relying on the collaboration of multiple subjects. Among the themes, educators may explore (cyber)-bullying, inclusion and disabilities, science, technology, and digital citizenship. As an operating mechanism, educators may encourage them to work independently, in pairs, or in groups. An exemplary scenario may appear as follows: 6–10 as the target age group, experience the value of being inclusive as an educational goal by encouraging teamwork as the operating mechanism. Pupils may be invited to narrate the first day of a novel school mate to deal with inclusion as theme. This proposal may involve literary skills, but also civic and geography.
2) **a quantitative survey** administered by Mentimeter[6] to collect feedback, use cases, and suggestions. Since the first feedback, it was clear that *Novelette* can be adapted to any subject and context, from bullying to civics education, from food education to inclusion.
3) **a scenario proposal** as individual, pair, or group activity. All educators opted to work in groups of four or five participants. Each group proposed a real use case in which a visual story could be worth more than verbose discussions. This resulted in five scenarios. The common elements were collaboration among students, and they mainly focused on the methodological aspects. Every group presented an original context that could take advantage of *Novelette*.

This phase results in a list of educators interested in participating in the *Novelette* project, inspiring use cases, and suggestions to move to the prototyping phase.

C. PROTOTYPING - USER-CENTERED DESIGN

During the prototyping phase, developers designed and implemented the *Novelette* architecture, interface, workflow, and features according to common patterns and expectations observed in the literature by analysing similar tools.

Novelette addresses privacy issues related to creating accounts for minors, the proposal of an interface provided with all the features expected by a graphical editor, such as an image library to select characters and backgrounds, the

[5]BIMED association: https://www.bimed.net/

[6]Mentimeter: https://www.mentimeter.com/

selection of colour as a background, and component manipulation such as image size control or text modification. The proposed interface limits as much as possible text attached to supported features often replaced by icons and images to address internationalisation issues, be inclusive, and also enable very young students to use it.

This phase resulted in a working prototype used to collect educators' feedback and suggestions to improve *Novelette*.

D. 1st ROUND OF THE Novelette REVISION - PARTICIPATORY DESIGN

In January 2020, a hands-on session with 10 educators was conducted. It was performed in the ISISLab at the University of Salerno, our research lab. Every educator was provided with a computer to test the platform in person.

First, a tutorial session took place to overview *Novelette* features already available at this stage, mainly concerning the editor interface offering basic features to manage scenes, such as add, clone and delete scenes, the image library to select characters and background, and the use of media content such as images and text. Then, a hands-on session was performed by letting participants free to create their stories without any constraint or predefined track by playing the student role. Three observers joined this phase to take note of all the raised issues and educators' comments, such as proposed features, improvements, and needed clarification. A brief questionnaire was administered to organise feedback and suggestions to inspire new features incorporated into the following implemented version. We report the questionnaire questions and the most commonly collected replies:

- *Comments on layout and improvement suggestions.* Import images from local storage and enhance the control of the educator side by enabling students' stories to be inspected and modified.
- *Suggestions to improve the authored produced.* Provide wider support for image modification, such as mirroring and positioning.
- *Other suggestions/comments.* Continue the collaboration between *Novelette* developers and end-users.

This phase resulted in a collection of technical improvements to make *Novelette* easier to use, both on the teacher and student sides. Moreover, educators manifested a great interest in joining the *Novelette* project by the collaborative design, in continuing it to improve *Novelette* further, and use it at school with their classes.

E. 2nd ROUND OF THE Novelette REVISION - PARTICIPATORY DESIGN

In February 2020, the 2nd round of revisions took place. As in the previous round, all interested partners freely joined it. In particular, 7 educators succeeded in participating, fewer than in the previous round due to the short notice. The protocol reflected the one followed during the previous round by first, overviewing the platform and the introduced features, second, performing a hands-on session, and finally collecting suggestions and feedback through a questionnaire. The collected proposals are primarily related to the undo mechanism, the possibility of attaching metadata to the authored story, such as a title and a brief description, and minor issues related to text management in the creator component. As in the previous round, this phase resulted in suggestions for improving *Novelette*.

F. BASELINE EVALUATION - PARTICIPATORY DESIGN

In June 2020, a *Novelette* baseline with all the features described in Section III was released. The event involved all interested educators and participants out of the educational context. Unlike previous events, the baseline evaluation was conducted remotely because of the COVID-19 pandemic. We first reviewed the features and workflow of *Novelette* to enable new participants to become familiar with the platform. We then provided focused tasks and a summary questionnaire to evaluate the system usability and the participants' perception. Section V-A provides details of the tasks performed and discusses the results.

V. EVALUATION

The main goal of this evaluation is the assessment of the *Novelette* usability for both educators and students. We performed a two-round assessment. First, we tested *Novelette* by involving educators participating in the design approach and performing the assessment in a controlled environment. This educators' evaluation round verifies whether and to what extent *Novelette* satisfies end-users expectations maturated during the design approach. Second, we evaluated the usability of *Novelette* in real settings by involving three primary school classes that used *Novelette* at school, without being supported by developers.

This section analyses each round of evaluation separately by detailing the research questions, participants, evaluation settings, and achieved results. It describes the adopted protocol and the questionnaires used in as many details as possible to make it replicable. Table 2 summarises the key aspects of the performed evaluation and the achieved results.

A. EVALUATION WITH EDUCATORS

1) RESEARCH QUESTION

The main goal of the research described in this article is the *Novelette* usability assessment according to educators involved in the co-creation process. By posing this objective as a Research Question (RQ), *RQ1* corresponds to "To what extent educators consider *Novelette* usable?".

2) PARTICIPANTS AND SETTING

11 users from the educational context were involved in the evaluation: 10 of them were educators, while a single user collaborated with schools. All participants were women. They belong to different institutions and cover 14 classes. 9 out of 14 were primary school classes, 3 out of 14 were secondary school classes and a single high-school institute. In a single

TABLE 2. Summary of evaluation results.

	Educators	Pupils
Participants	11	49
Setting	controlled environment	formal setting, at school
PROTOCOL		
1.	*Novelette* features tutorial	
2.	The incipit challenge	
3.	The suggestion mechanism	
PROTOCOL PHASES' DURATION		
1.	15 minutes	1 hour
2.	40 minutes	3 hours
3.	40 minutes	3 hours
DATA GATHERING		
After Scenario Questionnaire (ASQ) [66]		
System Usability Survey (SUS) [67], [68]		
Behavioural Intention (BI)		
RESULTS		
SUS	76	75
BI - intention to use *Novelette* again		
Range	1–7	1–5
Min	4	1
Mean	5.5	4.6
St.Dev.	1.2	0.7
Median	6	5
Max	7	5
BI - intention to suggest *Novelette* to others		
Range	1–7	1–5
Min	4	1
Mean	6	4.6
St.Dev.	0.9	0.9
Median	6	5
Max	7	5
Favorite feature	incipit (10/26) usage simplicity (6/26) suggestions (5/26) interface (5/26)	creativity support (19/49) usage simplicity (17/49) incipit (9/49) suggestions (4/49)

case, a participant replied that she was interested in contacting several schools without quantifying the number or qualifying the school level. All participants were Italian. Thus, both the tasks and the evaluation questionnaires were provided in their native language. Although they are geographically distributed in Italy, there is a predominant concentration of participants from the authors' native region, the Campania region, due to the desire to perform meetings and experiments in person, when possible.

While the meetings described in the collaborative design have been performed in person, the evaluation described in this section has been held online because of the constraints posed by COVID-19. Most of the participants also participated in the previous meetings, while two users were completely new.

During the evaluation, a *Novelette* developer played a moderating role in overviewing the *Novelette* features and conducting the protocol, while 3 developers were always available to clarify doubts and solve technical issues.

3) PROTOCOL

The evaluation took place online remotely, and lasted 2 hours. The moderator asked all participants to play the student role and assess the usability of the *Novelette* creator. First, the moderator introduced *Novelette* by focusing on its key aspects to deal with participants who had never experienced *Novelette* before and enabling all the participants to be aware of the available features. Second, participants were challenged to solve predefined tasks concerning literary artifices inspired by Rodari embedded in a digital learning environment. Finally, participants were invited to complete a questionnaire to note task-based observations and assess the *Novelette* usability. More details follow.

a: NOVELETTE FEATURES TUTORIAL - 15 MINUTES

The moderator performed a tutorial of *Novelette*'s main features by pointing out the working mechanism from the student side and the novelties introduced after the second meeting of the participatory design approach. The participants were spectators of this introductory phase.

b: THE INCIPIT CHALLENGE - 40 MINUTES

The participants were provided with a template narrating the initial part of the Rodari's tale entitled *The Land starting with S* (visible in Fig. 3). As anticipated, this tale narrates the land where object names start with S, and it completely alters an object's property. By putting it in *Novelette*, we provided the participants with an incipit to continue. This task aims to assess the ease of starting from a non-empty template and continuing someone else's story.

The participants were invited to start from this incipit and invent a short story, that is a story compound of one or few scenes, by inventing original objects whose features were completely revised by placing an S in front of its name. Participants were invited to select one of the images proposed by the *Novelette* library, add the image corresponding to an S in front of the chosen object, and add a caption describing the invented object. Once the time elapsed and all the participants submitted their stories, a showcase of the realised artefacts completed the task.

c: SUGGESTION PROVISION CHALLENGE - 40 MINUTES

The second task concerned the assessment of the usability of the suggestion mechanism. Participants were spurred in freely choosing a word, navigating the resulting analogies, and creating a story based on the experienced breadcrumb. To introduce this challenge, the moderator showed a guided example (1 min long) where, starting from the `dragon` term, she navigated the proposed analogies by experiencing the path `dragon > breathe > breeze > cool > mint > chocolate > ice cream > kiosk > itinerant`. Finally, the moderator showed the authored story concerning a little dragon whose breath smells like mint because it ate an ice cream bought from an itinerant kiosk.

4) DATA GATHERING

For each task, educators filled in an After Scenario Questionnaire (ASQ) [66] using a 7-scale questionnaire to evaluate 1) the degree of the perceived difficulty of the task by performing it through *Novelette*, 2) if the time to complete the task is perceived reasonable, 3) if the provided knowledge in the training phase is sufficient to complete the task. While the

first question provides an insight into the perceived usability, the second question subjectively quantifies the pleasure in using *Novelette*, while the latter estimates the facility in learning how to use *Novelette*. Participants were free to notify any experienced difficulty as an open question. At the end of the evaluation, the moderator provided the participants with a questionnaire to i) evaluate the system usability using a standardised questionnaire, widely adopted in the educational field [69], the SUS [67] questionnaire, and ii) verify the interest in using and proposing *Novelette* by the Behavioural Intentions (BI) survey. Finally, we collected comments and suggestions mainly as open questions.

5) RESULTS

The SUS score is 76. According to its interpretation, all the values between 68 and 80.3 classify the system as *above the average*. That means that *Novelette* is classified as *good*.

Concerning the BI results, there is an overall intention to reuse (mean score of 5.6 out of 7) and the real intention to propose the system to others (mean score of 6.2 out of 7).

More qualitative insights are enabled by the ASQ results, direct observations of moderators, and the collected comments as open questions. Participants assess that it is easy to start from an incipit (the 1st question related to the perceived complexity of beginning from an incipit within *Novelette* has a mean score, *M* of 6 out of 7). They consider the employed time to create a story starting from an incipit (average time of 23 minutes) reasonable (the 2nd question gained *M* equals 5.8 out of 7). The most promising result is related to the required explanation to create the story: they confirm that the short introduction to the *Novelette* environment is enough to use the platform (*M* of 6.7 out of 7).

Concerning the analogy lookup phase, they assess that the difficulty in inspecting the analogies is reasonable (*M* of 5.1 out of 7). During this challenge, participants experienced connection problems that negatively affected the user experience and the required time perception. The question related to the observation if the time needed in analogies lookup and exploitation gains a mean score of 4.9. In this case, the most promising result is related to the need for a concise introduction to the feature exploitation (*M* of 5.7 out of 7).

We collected opinions and suggestions by asking for rating their favourite feature(s) among the interface, usage simplicity, possibility of starting from an incipit, and the suggestion provision mechanism. Multiple selections were enabled. The incipit is the favourite feature (10 out of 26 votes), followed by usage simplicity (6 out of 26 votes), while the interface and the suggestion provision gain 5 out of 26 votes. Besides aspects strictly related to the *Novelette* environment, educators heavily appreciated the continuous involvement in designing and testing the platform and proposed several exploitation contexts. They were also seriously interested in proposing *Novelette* to their school principals in the following years.

They suggested introducing audio support, improving text management, and providing a wider library of images and characters. These suggestions inspired the features implemented in future *Novelette* releases.

B. EVALUATION WITH CHILDREN

While this article focuses on usability assessment, one of our previous articles [34] discusses the engagement level reached by the same group of pupils in inventing and authoring stories by *Novelette*. This resulted in high engagement, which was slightly higher in the male group. Educators who behaved as moderators during the evaluation asserted that adopting a technology-enhanced solution justifies these positive results. Moreover, it has the potential to engage males more than traditional means, such as paper and pencil.

1) RESEARCH QUESTION

The main goal of this evaluation was to assess the *Novelette* usability according to children. By posing this objective as an RQ, *RQ2* ''To what extent children consider *Novelette* usable?''.

2) PARTICIPANTS AND SETTING

49 children of an Italian primary school, ''Convitto Nazionale Giordano Bruno'', are involved. 49% females, 10 years old. The participants were divided into three groups according to their attended class. The same protocol was followed for each class. The activity took place during April and May 2021 in a formal school setting. It has been proposed and moderated by school educators as a curricular activity. Each children has been authorised by both parents through a written consent form by demonstrating that they were aware of the exploitation of *Novelette* and authorising the collection of feedback and comments. The University of Salerno undertook post-workshop data processing in an anonymous form to meet the data protection requirements.

3) PROTOCOL

The activity took place in presence, during 1-hour lesson per week dedicated to computer science and technology. It spanned over 8 weeks to give every child the possibility of actively joining the activity. Learners used a shared laptop during the lesson and, collaboratively, invented and told their stories based on themes proposed by the moderator. First, the moderator introduced *Novelette* and its main features as none of the involved children experienced *Novelette*. Among the proposed activities, learners experienced the incipit and the suggestion mechanisms, and all of the participants invented and authored a story via the *Novelette* creator by playing the student role. In both the invention and storytelling stages, participants were assisted by the moderator if needed. Details of the protocol follow.

a: NOVELETTE FEATURES TUTORIAL - 1 HOUR

The moderator introduced *Novelette* by showing how to access the platform, choose a template, create few story scenes, inspect available characters and backgrounds, add text, and apply basic manipulation to images (e.g., reduce

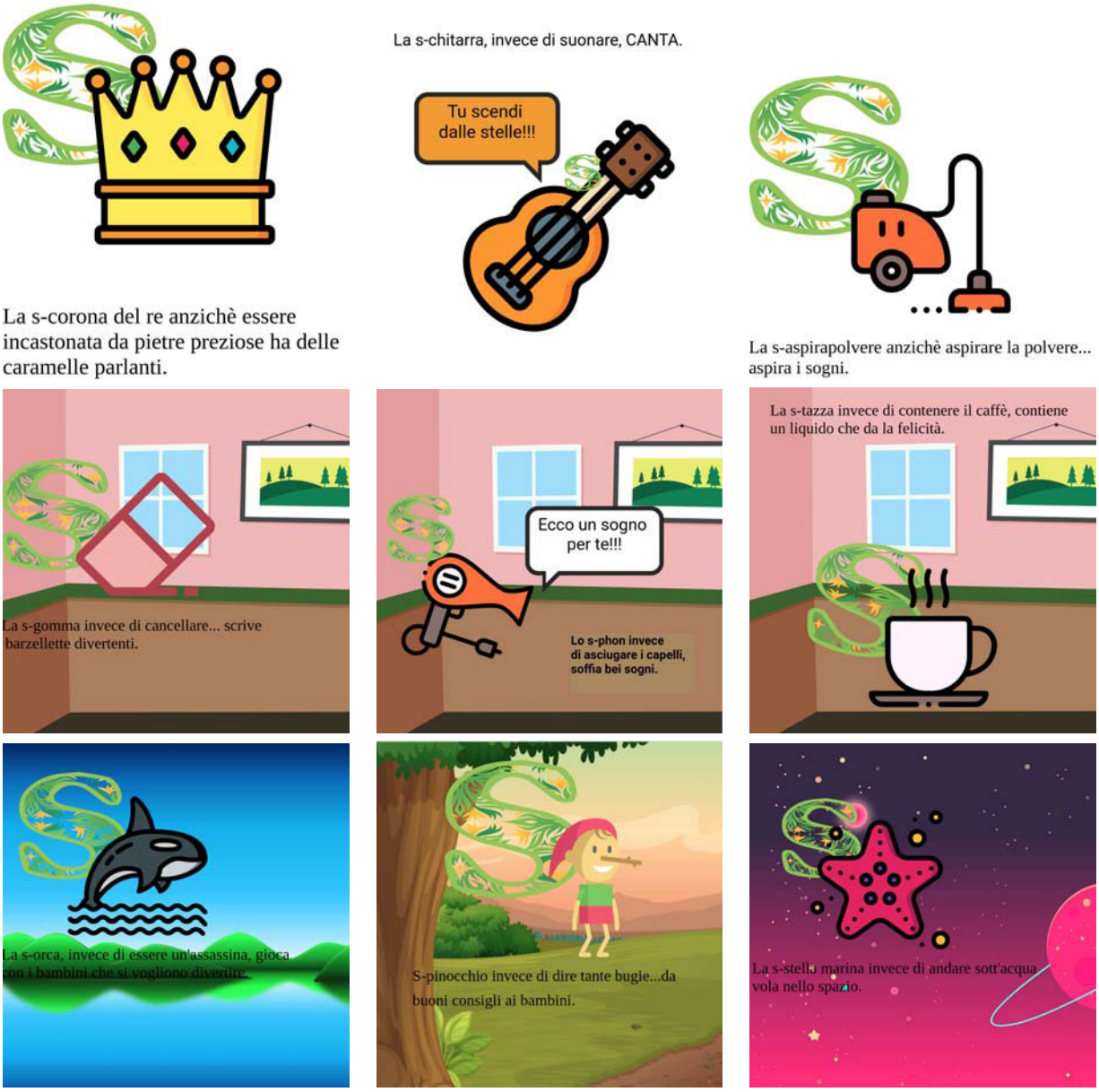

FIGURE 7. Stories authored by pupils continuing the incipit *the land starting with S.*

size) or text (e.g., change the font, colour, background colour). This allowed participants to familiarise themselves with the *Novelette* interface. The participants were spectators of this introductory phase.

b: THE INCIPIT CHALLENGE - 3 HOURS

As in the educators' evaluation, the moderator invited participants to test the incipit feature by continuing *The Land starting with S*. The moderator guided pupils in choosing a character among the available ones, inventing how the *S* can alter its behaviour, and creating a scene to tell the invented story. Children were invited to create a story via *Novelette* by working independently, asking for a mentor's or peer support if needed. Fig. 7 shows some of the authored stories.

This challenge was experienced as the possibility of making an imagination bloom without constraints. Pupils turned ordinary objects into magical thanks to the superpower infused by the prefix *s*. They had fun in proposing objects behaving exactly the opposite of their regular behaviour. For instance, Pinocchio is a tale where the main character is a liar, instead of the *s*-Pinocchio always tells the truth and gives suggestions to pupils. Most of the pupils invented objects able to make them happy, for example, the coffee cup that contains liquid happiness or the *s*-vacuum and the *s*-hair drier that blows dreams, the *s*-rubber that tells jokes. Some stories went in the direction of overcoming fears, such as, the whale that does not kill but instead plays with children. Others preferred playing on words, for example, the starfish

FIGURE 8. Results of the suggestion phase exploring ***participation*** and ***happiness***.

FIGURE 9. Detail of the suggestion phase starting from ***participation***.

behaved like a star by shining in the space instead of staying underwater.

c: SUGGESTION PROVISION CHALLENGE - 1 HOUR

The second task tested the suggestion provision mechanism to verify the usability of the proposed mechanism and to assess the extent to which children are inspired by analogies. During this task, educators encouraged students to start from a word assigned by the teacher, that is, *participation* or *happiness*, and use *Novelette* to find analogies that were mainly surprised and inspired them. It is worth noting that the pupils were unaware of the meaning of these words and tried to figure it how by exploring the suggested analogies. Learners were invited to select 10 words from the suggested ones and note them on a sheet. Then, they picked a single word from the pool of 10 and were challenged to justify the relationship between the starting and the chosen words by a graphical representation and a short textual depiction.

Fig. 8 reports some examples of the work produced by pupils, while Fig. 9 reports a single example where Serena (the author of the reported artwork), starting from *participation*, chose *participants* as analogy and justified it by saying that she attends her school (consequently, she is a participant). Starting from *participation*, pupils mainly chose i) *athlete* as athletes participate in matching and enjoying competition; ii) *football* as a team sport to play and team members participate as a group; iii) *manifestation* as it represents an opportunity to share opinions and participate with people interested in the same field to disseminate information on crucial topics, for example, on the environment and pollution; iv) *collaboration* as participating also means collaborating as in the participatory design; v) *share* as participants may share thought, objects, feelings, experiences and expertise.

Starting from *happiness*, pupils chose i) *serenity* as you are happy if you are at peace with everyone; ii) *joy* as a synonym of happiness; iii) *contagious* as people surrounded by happy people may become happy as well; iv) *bliss* as a fundamental feeling that every child should experience, always; v) *toast* as a way to manifest happiness by making a toast with friends.

4) DATA GATHERING

For each task, pupils were invited to fill in a simplified ASQ asking for i) the reached engagement level formulated as "Did you like to perform this task?", ii) the easiness in completing the task, and iii) if they required help. While the first two questions asked a rate according to a 5-Likert scale, the latter required a Yes/No reply. Moreover, they provided feedback and notified difficulties as a free text.

At the end of the evaluation, the moderator provided participants with a final questionnaire to i) evaluate the system usability according to a simplified version of the SUS and ii) their interest in using it again and proposing the tool to friends through the BI survey. Finally, the questionnaire collected comments and suggestions mainly as open questions.

Questionnaires used a language adequate to the age range of participants and adopted visual analogue scales for answers, which employed icons or images, easy to interpret by children, and concerning their feelings and opinions. Specifically, the moderators administered a simplified version of the SUS questionnaire [68]. In BI, the children rated if they i) desire to use *Novelette* again and if they ii) would propose *Novelette* to friends. Ratings were rated on Smiley-o-meter 5-point Likert scale ranging from not at all (1) to very much (5). Suggestions were collected as open-format questions inviting children to i) suggest what they would add, modify, or improve, ii) highlight what they liked more, and iii) what they liked less.

5) RESULTS

Regarding the usability evaluation, the SUS score was 75. According to the SUS score interpretation, all the values between 68 and 80.3 classify the system as *above the average*. This means that *Novelette* is classified as *good* by the children. 17 out of 49 complimented about *Novelette* and its features stating that "Novelette *is super-adapt to child and it is easy to use*" and "*it is perfect as it is despite minor issues*". 2 out of 49 asked for further simplifying *Novelette* by fixing technical aspects concerning text and image manipulation.

Regarding BI, there was an overall intention to propose *Novelette* to friends (mean score $M = 4.6$ out of 5, standard deviation $SD = 0.9$, 5 as median, minimum value $min = 1$ and a maximum value $max = 5$). Moreover, there is an overall intention to reuse it (mean score $M = 4.6$ out of 5, standard deviation $SD = 0.7$, 5 as median, minimum value $min = 2$ and maximum value $max = 5$). 9 out of 49 asked for unlimited access to the platform without a password to play with it by their PC or mobile devices.

More qualitative insights are offered by the modified ASQ results, direct observations returned by moderators, and feedback and suggestion reported as open questions. According to the first question of the modified ASQ, its mean score is at least equals to 4.49 out of 5 (45 replies), and its value is slightly higher in the task of narrating funny stories ($M = 4.62$ out of 5, 45 replies). According to the second question, modelling the easiness in performing the invention and the story authoring reached a mean score of at least 4 out of 5 (44 replies), but increased by experience. In fact, it reaches a slightly higher mean score during the second task, 4.14 out of 5 (43 replies). Similarly, during the first task, slightly less than half of the participants (20 out of 45) stated that they required help in accomplishing the assigned task, while they decreased to 16 out of 43 during the second task.

The experienced challenges correspond to features that children suggested to improve. In particular, children suggested the introduction of a wider set of images to the default library as background and characters, simplification of the text management, and image manipulation features.

19 out of 49 participants manifested a great appreciation for *Novelette* stating that they felt supported and encouraged to improve their creativity by inventing and creating stories, stating that ''Novelette *enables them to free their imagination*''. Regarding Rodari's style techniques, 9 out of 49 participants enjoyed the proposed incipit as they experienced the possibility of inventing objects altered by the S as an opportunity to free their imagination as there were no wrong or right replies, but only novel ideas. Moreover, 4 out of 49 explicitly stated that they loved the suggestion mechanism to play on words, and they felt scaffold in thinking out of the box and improving their creativity.

All of them agreed that *Novelette* could be exploited to create a story of interest. Once educators ask them what stories they would like to invent and create, they replied citing traditional tales, stories with their favourite fictional or real characters. Moreover, they would like to narrate about their personal experiences (e.g., birthdays or ceremonies), their daily life (e.g., talking about what they do at school), and stories about their pets (also transformed into fictional characters with superpowers). Among the most original proposals, we can cite ''My crazy year'' meaning that this child would like to talk about education at a distance during the COVID-19 pandemic and how it affected their education, friendships, habits, and daily life; stories about serious topics, such as, ''The land of books'' to highlight the importance of reading; or stories where characters swap their properties, e.g., the story of little red riding hood where the kid is the villain, perceived as an extension of the experienced incipit.

C. DISCUSSION

Novelette has been designed not only *for* education but *with* educators as they have been actively involved in the design approach addressing concrete needs that they face daily with pupils. As a result, this article assesses the usability score by involving both educators and pupils to verify to what extent *Novelette* is perceived as a usable visual storytelling digital environment, as well as to develop pupils' creativity.

Novelette is considered *usable* by educators (RQ1) and pupils (RQ2) as it achieved an SUS score of at least 75. Qualitatively speaking, involved participants successfully created stories stating that the interface is easy to be used both according to educators and children. According to involved educators, it is easy to learn how to exploit *Novelette*, stressing the intuitiveness of the proposed tool. Moreover, it demonstrates that users do not require technical support to use *Novelette*. The same pattern can be observed by working with pupils. They rarely asked for any support and, in most of the cases, peer support was enough to overcome challenges. By discussing with the moderators, children loved working collaboratively, and they asked for peer support to invent and author stories together. In fact, they think about the inventing part and the characters together to share and exchange opinions with friends. However, rarely they had concrete difficulties that required the moderators' intervention, and these difficulties were mainly concerned with formatting text that resulted in a slightly artificial functionality. Participants stated that they mainly experienced obstacles in the invention phase, while *Novelette* fully supported them in authoring the invented story. In fact, according to the ASQ, inventing stories is not an easy task. However, since the experienced difficulties decreased with experience, it seems that there is the possibility to improve creativity and inventiveness *by doing*.

Concerning the intention to use *Novelette* again or suggest it to others, both target groups seem to be particularly enthusiastic about working again with it. Educators promised to propose it to their classes in the immediate future, and classes joining the evaluation decided to include it in the set of tools used also the following year. Pupils were asked to continue working on it in the summer and requested access to *Novelette* at home, by their personal devices. A similar pattern has been observed in related work, such as Communics, where primary school pupils were so excited to use visual storytelling platforms at school that they asked to access them at home. It demonstrates that children were highly engaged in inventing and authoring stories by *Novelette*, as highlighted by the first question of the modified ASQ and as reported in another article of ours discussing the engagement level achieved by pupils in inventing and authoring stories by *Novelette* [34]. Concerning favourite features, educators were particularly interested in the incipit mechanism, probably as they perceived it as a way to distribute and assign tracks to all at once.

Furthermore, they considered it easy to use both for them and for their learners. Looking at favourite aspects with pupils' eyes, they were enthusiastic about the suggestion mechanism, perceived as the removal of any bannister, complete freedom in inventing unexpected story developments, and the possibility of inventing and telling any story of interest.

Studies assessing the role played by digital storytelling in schools are not rare. They cover heterogeneous dimensions, such as collaborative dimension [42], [48], engagement [34], [42], entertainment level [70], usability [71], [72], learning outcomes [43] or improvement in creativity [45]. All these contributions report positive results like those obtained in this article, demonstrating that digital storytelling is a promising approach to spur imagination and encourage pupils to actively improve their literary skills, both individually and collaboratively.

As classes might be composed of learners with special needs, it is crucial to assess the accessibility of the proposed tool to everyone, specifically those who have disabilities, allowing them to perceive, understand, navigate and interact with the Web. These disabilities cover all levels, including auditory, physical, speech, cognitive and neurological. Many tools have accessibility barriers that make it difficult for a person with a disability to use their interface. Automatic tools to measure accessibility assists behave as a preliminary check to sure that people with disabilities do not face roadblocks when accessing the platform. Among others, WAVE [7] and TAW [8] help developers make their web applications more accessible to individuals with disabilities. WAVE can identify many accessibility issues and web content accessibility guideline errors but also facilitates human evaluation of web content. They focus on issues that heavily impact end-users, facilitate human evaluation, and educate about web accessibility. We used both these tools to quantify the accessibility of *Novelette* automatically. While TAW returns a single problem concerning the difficulty in automatically retrieving the system language, WAVE states that no errors were detected. It represents a quantitative and automatic check that *Novelette* might be accessible by anyone irrespective of their characteristics.

VI. LIMITATIONS

Novelette supports collaboration among educators and learners in terms of exchange materials and artifacts visibility. However, *Novelette* does not scaffold storytellers in co-authoring stories. Further effort should be invested in supporting collaboration among learners. However, as made evident by the performed evaluation, learners easily organise themselves in groups, invent stories collaboratively, and author them one by one by guaranteeing peer support.

While the automatic evaluation of *Novelette* accessibility demonstrates that *Novelette* seems to be inclusive and can be easily exploited by learners with disabilities, further effort should be invested in validating it with real users.

[7]WAVE: `https://wave.webaim.org`
[8]TAW: `https://www.tawdis.net`

Concerning aspects that can be assessed in working with *Novelette*, this study quantifies *Novelette* usability and related work analyses learners' engagement [34] in inventing and authoring stories by *Novelette*. Moreover, *Novelette* might support educators and learners in quantifying learning outcomes and reached creativity levels while performing storytelling.

VII. CONCLUSION AND FUTURE WORK

Despite the wide awareness of the advantages of educational digital storytelling, educators still feel that schools lack opportunities, skills, and tools to guide pupils in developing their creativity. Hence, we proposed *Novelette*, a digital learning environment for educational digital storytelling. It supports both educators in class management and pupils in inventing and authoring stories. While most of the available tools only behave as editor interfaces, *Novelette* embeds well-known approaches defined by Rodari to inspire storytellers and guide them in the invention phase.

Novelette has not only to be designed *for* educators, but it resulted by a collaborative design approach to propose a tool that actively involve educators in the entire design and development phases. Thus, *Novelette* has been designed *with* educators. As a result, this article retraces the entire design process by reporting the performed steps and the educators' role, describing the resulting tool, and demonstrating how *Novelette* can be exploited in a concrete use case at school. Finally, it assesses *Novelette* usability by involving both educators and pupils. While educators tested *Novelette* in a controlled environment, pupils evaluated it in a real context, at school, during their curricular activities. As a result, *Novelette* is very *usable* for both target groups. Qualitatively speaking, pupils appreciated the possibility to use a clear and easy-to-use tool for authoring stories, and they felt the opportunity to increase their creativity. Educators demonstrated high satisfaction by using a controlled environment to exchange materials with learners and supervise pupils' work.

In the future, we aim to overcome issues reported by educators and pupils in the evaluation reports. In terms of usability, we aim to assess its usability and ease of use in remote activities as COVID-19 taught us that it is crucial to be ready to move an activity from in-person to a remote configuration [37]. We also aim to quantify the role plaid by the collaborative dimension in terms of learning outcomes and improvement in participants' creativity, similar to the experience reported in the literature [42], [48], by also considering participants with disabilities, such as dyslexia. Finally, as good usability is a precursor of a successful learning approach [38], we aim to investigate further the extent to which *Novelette* succeeds in supporting pupils in (literary) learning and in developing creative skills. Thus, we aim to assess the learning and creativity outcomes achieved thanks to the *Novelette* support, by first considering standard approaches used in the literature [43], [45] and, if needed, proposing novel assessment criteria. Finally, it would be interesting to perform a longitudinal evaluation by

involving the same participants in a novel evaluation to assess their retention level and the long-term engagement once the initial enthusiasm concerning novelties disappears.

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REFERENCES

[1] C. Tong, R. Roberts, R. Borgo, S. Walton, R. Laramee, K. Wegba, A. Lu, Y. Wang, H. Qu, Q. Luo, and X. Ma, "Storytelling and visualization: An extended survey," *Information*, vol. 9, no. 3, p. 65, Mar. 2018.
[2] H. Moradi and H. Chen, "Digital storytelling in language education," *Behav. Sci.*, vol. 9, no. 12, p. 147, Dec. 2019.
[3] C. Chan and C. Yau, "Digital storytelling for social work interventions," *Social Work*, May 2019. [Online]. Available: https://scholar.google.com/scholar_lookup?title=Digital%20storytelling%20for%20social%20work%20interventions&publication_year=2019&author=C.%20Chan&author=C.%20Yau
[4] J. R. Botfield, C. E. Newman, C. Lenette, K. Albury, and A. B. Zwi, "Using digital storytelling to promote the sexual health and well-being of migrant and refugee young people: A scoping review," *Health Educ. J.*, vol. 77, no. 7, pp. 735–748, Dec. 2017.
[5] S. Madigan, *Narrative Therapy*. Washington, DC, USA: American Psychological Association, 2011.
[6] E. Segel and J. Heer, "Narrative visualization: Telling stories with data," *IEEE Trans. Vis. Comput. Graphics*, vol. 16, no. 6, pp. 1139–1148, Nov. 2010.
[7] J. Schell, *The Art of Game Design: A Book of Lenses*. San Mateo, CA, USA: Morgan Kaufmann, 2008.
[8] F. Clarizia, S. Lemma, M. Lombardi, and F. Pascale, "An ontological digital storytelling to enrich tourist destinations and attractions with a mobile tailored story," in *Green, Pervasive, and Cloud Computing*, vol. 10232. Cham, Switzerland: Springer, Apr. 2017, pp. 567–581.
[9] A. Schmoelz, "Enabling co-creativity through digital storytelling in education," *Thinking Skills Creativity*, vol. 28, pp. 1–13, Jun. 2018.
[10] J. Bruner, *Acts of Meaning*. Cambridge, MA, USA: Harvard Univ. Press, 1990.
[11] J. Wu and D.-T.-V. Chen, "A systematic review of educational digital storytelling," *Comput. Educ.*, vol. 147, Apr. 2020, Art. no. 103786.
[12] M. E. Hess, "A new culture of learning: Digital storytelling and faith formation," *Dialog*, vol. 53, no. 1, pp. 12–22, Mar. 2014.
[13] K. Guse, A. Spagat, A. Hill, A. Lira, S. Heathcock, and M. Gilliam, "Digital storytelling: A novel methodology for sexual health promotion," *Amer. J. Sexuality Educ.*, vol. 8, no. 4, pp. 213–227, Oct. 2013.
[14] R. Aylett, S. Louchart, J. Dias, A. Paiva, and M. Vala, "FearNot!—An experiment in emergent narrative," in *Intelligent Virtual Agents*. Berlin, Germany: Springer, Sep. 2005, pp. 305–316.
[15] S. Marsella, W. L. Johnson, and C. Labore, "Interactive pedagogical drama for health interventions," in *Proc. Artif. Intell. Educ.*, Jan. 2003, pp. 341–348.
[16] K. Mitgutsch and N. Alvarado, "Purposeful by design? A serious game design assessment framework," in *Proc. Found. Digit. Games*, vol. 12, May 2012, pp. 121–128.
[17] W. Min, M. H. Frankosky, B. W. Mott, E. N. Wiebe, K. E. Boyer, and J. C. Lester, "Inducing stealth assessors from game interaction data," in *Artificial Intelligence in Education*, vol. 10331. Cham, Switzerland: Springer, Jun. 2017, pp. 212–223.
[18] J. Rowe, L. Shores, B. Mott, and J. Lester, "Integrating learning, problem solving, and engagement in narrative-centered learning environments," *Int. J. Artif. Intell. Educ.*, vol. 21, no. 1, pp. 115–133, Jan. 2011.
[19] S. McAleese and J. Kilty, "Stories matter: Reaffirming the value of qualitative research," *Qualitative Rep.*, vol. 24, no. 4, pp. 822–845, Apr. 2019.
[20] W. Qiongli, "Commercialization of digital storytelling: An integrated approach for cultural tourism, the Beijing Olympics and wireless VAS," *Int. J. Cultural Stud.*, vol. 9, no. 3, pp. 383–394, Sep. 2006.
[21] H. Arendt, *The Recovery of the Public World*. New York, NY, USA: St. Martin's Press, 1979.
[22] F. Collins, "The use of traditional storytelling in education to the learning of literacy skills," *Early Child Develop. Care*, vol. 152, no. 1, pp. 77–108, Jan. 1999.
[23] G. Rodari, *The Grammar of Fantasy*. Einaudi, Torino: Einaudi Ragazzi, 1973.
[24] Y.-F.-D. Yang, "Multimodal composing in digital storytelling," *Comput. Composition*, vol. 29, no. 3, pp. 221–238, Sep. 2012.
[25] J. Zipes, *Creative Storytelling: Building Community/Changing Lives*. Evanston, IL, USA: Routledge, 2013.
[26] J. B. Ohler, *Digital Storytelling in the Classroom: New Media Pathways to Literacy, Learning, and Creativity*. Thousand Oaks, CA, USA: Corwin Press, 2013.
[27] B. R. Robin, "Digital storytelling: A powerful technology tool for the 21st century classroom," *Theory Into Pract.*, vol. 47, no. 3, pp. 220–228, Jul. 2008.
[28] L. Ryan, *The Visual Imperative: Creating a Visual Culture of Data Discovery*. San Mateo, CA, USA: Morgan Kaufmann, 2016.
[29] S. Bateman, R. Mandryk, C. Gutwin, A. Genest, D. Mcdine, and C. Brooks, "Useful junk? The effects of visual embellishment on comprehension and memorability of charts," in *Proc. SIGCHI Conf. Hum. Factors Comput. Syst.*, vol. 4, Apr. 2010, pp. 2573–2582.
[30] B. Smith and J. Monforte, "Stories, new materialism and pluralism: Understanding, practising and pushing the boundaries of narrative analysis," *Methods Psychol.*, vol. 2, Nov. 2020, Art. no. 100016.
[31] Erasmus+. (Dec. 24, 2020). *Survey on Creativity—Results, School Education Gateway*. Accessed: Oct. 11, 2021. [Online]. Available: https://www.schooleducationgateway.eu/en/pub/viewpoints/surveys/survey-on-creativity.htm
[32] R. Cachia and A. Ferrari, "Creativity in schools: A survey of teachers in Europe," Publications Office Eur. Union, Luxembourg City, Luxembourg, Tech. Rep. EUR 24585 EN, JRC59232, Nov. 2010.
[33] A. Addone, R. De Donato, G. Palmieri, M. A. Pellegrino, A. Petta, V. Scarano, and L. Serra, "Visual storytelling by novelette," in *Proc. 24th Int. Conf. Inf. Vis. (IV)*, Sep. 2020, pp. 723–728.
[34] A. Addone, G. Palmieri, and M. A. Pellegrino, "Engaging children in digital storytelling," in *Proc. 11th Int. Conf. Methodol. Intell. Syst. Technol. Enhanced Learn.*, Sep. 2021, pp. 261–270.
[35] *Ergonomics of Human-System Interaction*, Standard ISO 9241-210, 2019. Accessed: Oct. 11, 2021. [Online]. Available: https://www.iso.org/obp/ui/#iso:std:iso:9241:-210:ed-2:v1:en
[36] P. Bourges-Waldegg, L. Moreno, and T. Rojano, "The role of usability on the implementation and evaluation of educational technology," in *Proc. 33rd Annu. Hawaii Int. Conf. Syst. Sci.*, Feb. 2000, p. 7.
[37] C. Ardito, M. F. Costabile, M. D. Marsico, R. Lanzilotti, S. Levialdi, T. Roselli, and V. Rossano, "An approach to usability evaluation of e-learning applications," *Universal Access Inf. Soc.*, vol. 4, no. 3, pp. 270–283, Mar. 2006.
[38] M. F. Costabile, M. D. Marsico, R. Lanzilotti, V. L. Plantamura, and T. Roselli, "On the usability evaluation of e-learning applications," in *Proc. 38th Annu. Hawaii Int. Conf. Syst. Sci.*, Jan. 2005, p. 6b.
[39] N. Akhtar, N. Tabassum, A. Perwej, and Y. Perwej, "Data analytics and visualization using tableau utilitarian for COVID-19 (coronavirus)," *Global J. Eng. Technol. Adv.*, vol. 3, no. 2, pp. 28–50, May 2020.
[40] A. Beheshti, A. Tabebordbar, and B. Benatallah, "iStory: Intelligent storytelling with social data," in *Proc. Companion Proc. Web Conf.*, Apr. 2020, pp. 253–256.
[41] H. O. Obie, C. Chua, I. Avazpour, M. Abdelrazek, J. Grundy, and T. Bednarz, "Authoring logically sequenced visual data stories with gravity," *J. Comput. Lang.*, vol. 58, Jun. 2020, Art. no. 100961.
[42] C. B. Rutta, G. Schiavo, M. Zancanaro, and E. Rubegni, "Collaborative comic-based digital storytelling with primary school children," in *Proc. Interact. Design Children Conf.*, Jun. 2020, pp. 426–437.

[43] L. Colodeeva, "Teaching writing: Integrating digital storytelling into the classroom," *Buletinul Ştiinţific al Universităţii de Stat Bogdan Petriceicu Hasdeu din Cahul, Seria Stiinte Umanistice*, vol. 9, no. 1, pp. 33–42, 2019.
[44] J. M. Muñoz-González, E. M. Vega-Gea, C. Ballesteros-Regaña, and M. D. Hidalgo-Ariza, "Psychometric study of a scale of measurement of the digital stories creation using utellstory," *Sustainability*, vol. 12, no. 8, p. 3204, Apr. 2020.
[45] E. Wahjuningsih, A. Santihastuti, I. Kurniawati, and U. Arifin, "'Storyboard that' platform to boost students' creativity: Can it become real?" *IOP Conf. Ser., Earth Environ. Sci.*, vol. 485, Jun. 2020, Art. no. 12095.
[46] Y. Topkaya and Y. Doğan, "The effect of educational comics on teaching environmental issues and environmental organizations topics in 7th grade social studies course: A mixed research," *Egitim ve Bilim*, vol. 45, no. 201, pp. 167–188, Dec. 2019.
[47] M.-H. Chiang, "Exploring the effects of digital storytelling: A case study of adult L2 writers in Taiwan," *Int. Academic Forum J. Educ.*, vol. 8, no. 1, pp. 65–82, Mar. 2020.
[48] F. Kılıçkaya, "Learners' perceptions of collaborative digital graphic writing based on semantic mapping," *Comput. Assist. Lang. Learn.*, vol. 33, nos. 1–2, pp. 58–84, Jan. 2019.
[49] A. A. Myers, A. J. Ko, C. Scaffidi, S. Oney, Y. Yoon, K. Chang, M. B. Kery, and T. J.-J. Li, "Making end user development more natural," in *New Perspectives in End-User Development*. Cham, Switzerland: Springer, Aug. 2017, pp. 1–22.
[50] S. Yadav, P. Chakraborty, and P. Mittal, "User interface of a drawing app for children: Design and effectiveness," in *Proc. Int. Conf. Innov. Comput. Commun.*, Jan. 2021, pp. 53–61.
[51] X. Shu, J. Wu, X. Wu, H. Liang, W. Cui, Y. Wu, and H. Qu, "DancingWords: Exploring animated word clouds to tell stories," *J. Vis.*, vol. 24, no. 1, pp. 85–100, Sep. 2020.
[52] R. Navigli and S. P. Ponzetto, "BabelNet: The automatic construction, evaluation and application of a wide-coverage multilingual semantic network," *Artif. Intell.*, vol. 193, pp. 217–250, Aug. 2012.
[53] J. F. Sowa, "Semantic networks," in *Encyclopedia of Cognitive Science*. Atlanta, GA, USA: American Cancer Society, 2006.
[54] R. D. Donato, M. Garofalo, D. Malandrino, M. A. Pellegrino, and A. Petta, "Education meets knowledge graphs for the knowledge management," in *Proc. 10th Int. Conf. Methodol. Intell. Syst. Technol. Enhanced Learn. Workshops*, Aug. 2020, pp. 272–280.
[55] H. Vargas, C. B. Aranda, A. Hogan, and C. López, "RDF explorer: A visual SPARQL query builder," in *Proc. Int. Semantic Web Conf. (ISWC)*, vol. 11778, Oct. 2019, pp. 647–663.
[56] P. Bellini, P. Nesi, and A. Venturi, "Linked open graph: Browsing multiple SPARQL entry points to build your own LOD views," *J. Vis. Lang. Comput.*, vol. 25, no. 6, pp. 703–716, Dec. 2014.
[57] S. Mirri, M. Roccetti, and P. Salomoni, "Collaborative design of software applications: The role of users," *Hum.-Centric Comput. Inf. Sci.*, vol. 8, no. 1, p. 6, Dec. 2018.
[58] M. Berendsen, J. Hamerlinck, and G. Webster, "Digital story mapping to advance educational atlas design and enable student engagement," *ISPRS Int. J. Geo-Inf.*, vol. 7, no. 3, p. 125, Mar. 2018.
[59] F. Khalid and T. El-Maliki, "Teachers' experiences in the development of digital storytelling for cyber risk awareness," *Int. J. Adv. Comput. Sci. Appl.*, vol. 11, no. 2, pp. 186–191, 2020.
[60] M. J. Koehler and P. Mishra, "Teachers learning technology by design," *J. Comput. Teacher Educ.*, vol. 21, no. 3, pp. 94–102, 2005.
[61] E. B.-N. Sanders and P. J. Stappers, "Co-creation and the new landscapes of design," *CoDesign*, vol. 4, no. 1, pp. 5–18, Sep. 2008.
[62] D. A. Norman and S. W. Draper, *User Centered System Design; New Perspectives on Human-Computer Interaction*. Mahwah, NJ, USA: Lawrence Erlbaum Associates, 1986.
[63] D. Schuler and A. Namioka, *Participatory Design: Principles and Practices*. Boca Raton, FL, USA: CRC Press, 1993.
[64] S. D. Jacobs, "The use of participatory action research within education–benefits to stakeholders," *World J. Educ.*, vol. 6, no. 3, pp. 48–55, Jun. 2016.
[65] J. S. Clark, S. Porath, J. Thiele, and M. Jobe, *Action Research*. Manhattan, KS, USA: New Prairie Press, 2020.
[66] J. R. James, "Psychometric evaluation of an after-scenario questionnaire for computer usability studies: The ASQ," *ACM SIGCHI Bull.*, vol. 23, no. 1, pp. 78–81, Jan. 1991.
[67] J. R. Lewis and J. Sauro, "The factor structure of the system usability scale," in *Proc. Int. Conf. Hum. Centered Design*, vol. 5619, Jul. 2009, pp. 94–103.
[68] C. Putnam, M. Puthenmadom, M. A. Cuerdo, W. Wang, and N. Paul, "Adaptation of the system usability scale for user testing with children," in *Proc. Extended Abstr. CHI Conf. Hum. Factors Comput. Syst. (CHI EA)*, Apr. 2020, pp. 1–7.
[69] P. Vlachogianni and N. Tselios, "Perceived usability evaluation of educational technology using the system usability scale (SUS): A systematic review," *J. Res. Technol. Educ.*, pp. 1–18, Feb. 2021. [Online]. Available: https://www.tandfonline.com/action/showCitFormats?doi=10.1080%2F15391523.2020.1867938&area=0000000000000001
[70] A. A. Mutalib, N. Aziz, and Z. A. Shaffiei, "Digital storytelling makes reading fun and entertaining," *Int. J. Comput. Appl.*, vol. 18, no. 1, pp. 20–26, Mar. 2011.
[71] P.-F. Wu, K.-Y. Fan, and Y.-T. Liao, "Developing and assessing the usability of digital manipulative storytelling system for school-age children," in *Proc. 3rd Int. Conf. Syst. Informat. (ICSAI)*, Nov. 2016, pp. 465–470.
[72] P.-F. Wu, H.-J. Hu, F.-C. Wu, and K.-Y. Fan, "The evaluation on the usability of digital storytelling teaching system in teaching," in *Learning and Collaboration Technologies. Technology in Education*. Cham, Switzerland: Springer, May 2017, pp. 473–487.

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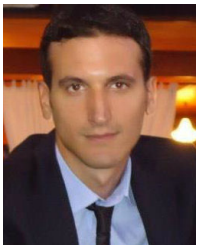

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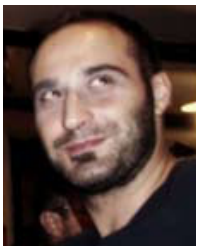

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