

## **Guidelines targeting game designers**

# SuperCyberKids Deliverable no. D4.3

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Abstract	The deliverable (D4.3) outlines a methodology that, starting with a game (existing or created from scratch), culminates in the formulation of game-based learning activities tailored for specific contexts. The methodology corresponds with the SuperCyberKids Learning Framework (D2.1) (SCKLF), which provides a competence-based framework for instructing cybersecurity to pupils aged 8 to 13. The process entails mapping current games to the framework and offering suggestions for competence-oriented game design. The second phase emphasizes the creation of context-specific learning activities by means of a tool named Flexibility Table.	
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## 1 Introduction

The deliverable D4.3, Guidelines for Game Designers, was formulated in the project proposal to provide guidance to game designers and developers for the adaptation and localization of existing or newly made-for-purpose cybersecurity games for adoption in various situations.

Throughout the project, collaboration between partners has cultivated a profound understanding of the necessity to examine the adaptability of game-based learning initiatives from a broad viewpoint.

This understanding necessitated expanding the discourse beyond merely formulating a rationale for the adaptation of games to include the pedagogical planning essential for the effective implementation of game-based learning initiatives in particular contexts<sup>1</sup>.

In this perspective, the deliverable presents a methodology that, starting from a game (already existing or created by scratch) leads to the definition of game-based learning activities tailored for specific contexts.

The methodology is aligned with the theoretical framework adopted in the project, which emphasizes competence-based education. So, this deliverable seeks to convey to game designers and pedagogical planners of game-based activities a sense of the project's vision of competence-based education as applied to teaching cybersecurity to young students aged 8 to 13.

Consequently, we start by briefly introducing competence-based education while also delineating the rationale for its compatibility with game-based learning, particularly in the context of employing serious games in education.

Moreover, we recall the <u>SuperCyberKids Learning Framework</u> (D2.1) (SCKLF), which delineates the competence framework for cybersecurity education targeting learners aged 8 to 13. We also present a new tool (the SCKLF ontology tool) specifically designed to support the exploration of the competence framework. Then the adaptation methodology is presented.

The first phase of the proposed methodology aims to create a competence-based mapping of the intended game. This phase involves mapping pre-existing cybersecurity games with the competence framework that the project has produced. Consequently, we describe the process for mapping existing games in relation to the framework. The methodology, initially applied to two case studies, the games "Spoofy" and "Nabbovaldo and Cyber Blackmail," has been generalized for use with other cybersecurity-themed games.

In our proposal, the SCKLF not only facilitates the mapping of existing games but also serves as a guide for the creation of new ones. Thus, we provide guidelines for competence-based game design, informed by the concepts outlined in Deliverable D3.1 - Reference framework for integration of the SCK game-based learning ecosystem on cybersecurity into school curricula – guidelines for schools.

Next, we present the second phase of the methodology. The aim is to guide the design of learning activities tailored for specific contexts and based on the games previously analysed or created. To this end, we present and delineate a tool named the Flexibility Table. This tool is designed specifically to facilitate the design of newly developed instructional activities.

<sup>&</sup>lt;sup>1</sup> When we mention specific settings, we are not solely addressing issues of linguistic adaptation; we are also considering contexts that vary in terms of cultural and/or socio-economic dimensions.

## 2 Competence-based education

Competency-based education (CBE) is an educational methodology designed to guarantee the success of all students, foster equity in learning, and amalgamate academic and vocational experiences (Sturgis et al., 2011; Lopez et al., 2017; Casey and Sturgis, 2018; Levine and Patrick, 2019). Initially introduced in the 1970s by the US Department of Education, Competency-Based Education (CBE) is currently gaining prominence throughout all educational settings, including K-12 institutions. In 2006, the European Union (EU) proposed key competencies for lifelong learning (Council of the European Union, 2006), urging member states to formulate strategies for its implementation.

The initial working definition of CBE was presented in 2011 during the inaugural National Summit on K-12 Competency-Based Education, which offered direction for comprehending and standardizing concepts (Sturgis et al., 2011). The 2017 National Summit on K-12 Competency-Based Education refined this definition, affirming its significance in the contemporary educational context (Levine and Patrick, 2019).

The revised definition of competency-based education (CBE) is relevant across all educational tiers and comprises seven foundational principles: students are consistently empowered to make significant decisions regarding their learning experiences; assessments are meaningful, constructive, and empowering; students receive prompt, tailored support according to their unique learning requirements; students advance based on demonstrable mastery; students engage in active learning through diverse pathways and varied pacing; strategies to promote equity for all students are integrated into the culture, structure, and pedagogy of educational institutions; and rigorous, standardized expectations for learning are clear, transparent, measurable, and transferable.

In conventional educational settings, student advancement is predominantly dictated by seat time (i.e. time devoted to instruction), resulting in gaps that are challenging to bridge over time (Bryant, 2013). CBE underscores that students should advance though demonstrating readiness, namely when they can exhibit mastery of the requisite competence. This suggests the need to schedule individual assessments within an acceptable timeframe to accommodate the diverse circumstances and requirements of each student.

It is essential to reevaluate the methodology of assessment, including both the formal aspects of competency evaluation and the principles of opportunity and transparency. Clearly and transparently communicating assessment criteria and metrics to learners can effectively aid them in understanding the necessary actions to improve competence and monitor their progress.

Focusing on competencies suggests that learning units, or modules created for competence acquisition, might be significantly more interdisciplinary than is conventionally the case. The organization of interdisciplinary modules would facilitate learners' comprehension of the dynamics and content characterising various curricula, thereby (a) enhancing their understanding of the overarching concepts that inform the development of a learning plan, and (b) potentially elevating their engagement and participation levels.

Competence-based education (CBE) is a flexible and adaptive learning strategy that emphasizes the cultivation of flexibility, lifelong learning, and comprehensive growth. CBE emphasizes the attainment of skills, knowledge, and attitudes for optimal performance in educational and professional environments, and it structures learning trajectories to be both individualized and balanced. CBE also fosters the development of students' preparedness for future professional endeavours in diverse social and occupational environments, while also promoting the skills essential for developing active citizenship.

CBE promotes flexibility, adaptation, and personalization of the educational process to suit particular learning environments and individual preferences. It facilitates the integration of learning in both formal and informal contexts, acknowledging that education can transpire outside conventional academic settings. Moreover, CBE facilitates self-directed study programs, enabling learners to customize their educational experiences according to their specific needs and interests. The principle of self-responsibility is fundamental to CBE, enabling learners to assume control of their educational journey and tailor it to their individual learning preferences.

The incorporation of technology in competency-based education plays a role of crucial importance. It enhances the design, execution, and assessment of educational activities, fostering flexibility and accommodating diverse learning styles and individual requirements.

Diverse digital platforms and ICT tools have arisen to facilitate the design, execution, and assessment of CBE educational initiatives by promoting and customizing these undertakings to particular learning contexts and individual requirements. Digital tools are beneficial for managing individual learning outcomes to incorporate flexibility and adaptability in curricula. They facilitate the design and execution of tailored learning activities, addressing diverse learning styles and individual requirements. In particular, in the context of 'knowing how to do a task and demonstrating mastery in doing so', one category of ICT tools is particularly appropriate: Serious Games (SGs). Indeed, being simulative by their very nature, Serious Games present perfect contexts for students to learn and, above all, to practise and gain experience in virtual contexts that are not only completely safe, they can retain key features shared with real ones. In other words, Serious Games allow students to have experiences that they would otherwise be unlikely to have during the learning and training process, either because prohibitively expensive or because of the health risks involved: just think of the experiences that trainee pilots can safely have in a flight simulator and on how difficult and risky this would be to have otherwise.

Moreover, another of the great advantages offered by Serious Games with regard to competence-based education is the pacing of the individual student's progress: especially in the context of single-player games, students are free to progress between levels according to the level of mastery they have demonstrated. This feature helps to decouple the individual's progress from that of the whole group (something that usually cannot happen in traditional educational contexts due to organisational constraints and the necessary presence of an instructor) and provides the flexibility required by a competence-based approach. Similarly, Serious Games naturally allow non-linear and modular learning paths. This enables a level of customisation on the individual learner (aided by automatic systems) that is difficult to achieve in traditional contexts and that is increasingly required by the highly heterogeneous contexts that characterise today's education.

Finally, the very simulative nature of Serious Games makes it possible - with appropriate design - to use them to assess the competencies and the level of mastery achieved by individual students. While this type of assessment is in fact difficult to carry out in traditional education, the option of testing the student on a precise task and automatically collecting data related to the way in which the task is carried out is representative of a more precise tool that better fits the concept of demonstrating the level of mastery achieved.

## 3 SuperCyberKids Learning Framework: the ontology tool

The SCKLF provides an overview of the type of content, the skills and the domains which a cybersecurity game can draw from. Six specific domains were identified as part of the framework, 1) Malicious Code, 2) Safety, 3) Abusive Content, 4) Fraud, 5) Preventative Techniques, and 6) Data Protection. Each of these domains were then further divided into categories based on the responses that a user could take to an attack in the domain 1) Identify, 2) Protect, 3) Detect, 4) Respond, and 5) Recover.

This five-part division extended the three subdivisions previously recommended by La Piedra (2024), enabling the skills to be organised not only by domain but also by their context of use. This approach resulted in a comprehensive matrix of the 141 skills.

As described in the Deliverable <u>D2.1 SuperCyberKids Learning Framework</u>, we decided to use an ontology to support the identification, definition, and formalisation of the competencies involved in the cybersecurity domain.

Ontologies represent a valid and effective tool for manipulating, formalizing and sharing knowledge. To fulfil this purpose, ontologies precisely define concepts and the different relationships that bind these concepts. Thanks to their characterizing features, they enable human beings to perform and complete tasks in collaboration with machines. They could easily be described as the backbone of the semantic web. Their potentialities manifest themselves and are fully realized when they are made freely accessible to the public.

Specifically, the ontology created within the SCKLF is a tool aimed at formalising and mapping the knowledge related to the competences identified as fundamental in the learning contexts intercepted by the project. Such a mapping and formalisation may be particularly useful in constructing all types of educational interventions on the topics covered by the project, precisely because it has the power to make evident and tangible the network of concepts, and the relationships between them, underlying the foundational skills related to cybersecurity in children between the ages of 8 and 13. In particular, such a tool may also be useful in designing Serious Games, in addition to more traditional educational paths.

At the same time, the form in which an ontology is often formalised - descriptive files in RDF format is difficult for a non-technical audience to read and understand. One of the most frequently used alternatives to make the knowledge mapped by an ontology usable and accessible is the use of graphs. In the case of the SCK ontology, however, the vastness of the identified subdomains means that even navigating a graph representing this information is not straightforward, as was also emphasised by the internal feedback gathered by the project partners. In order to meet these needs, and to ensure that the valuable knowledge mapped by the ontology can also be systematised outside the partnership, the CNR has developed a new tool to explore the network of relations characterising the above-mentioned knowledge in a guided and simplified manner.

The tool, publicly available at <u>http://scklf.itd.cnr.it/explorer/</u>, allows users to search by topic for the skills identified and mapped within the SCK ontology.

Following the entry of a topic in fact, the tool provides a list of skills correlated with that topic, ordered by relevance. This correlation is inferred from the relationships between the knowledge elements in the ontology. Similarly, the relevance index is inferred from the distance between the identified competence and the elements intercepted by the user's query, and provides an index of how strong - or weak - the link between them is.

buly	٩
Use Strategies To Protect Against And Prevent Cyberbullying [Relevance Index: 8]	~
Develop And Implement The Correct Actions in Cases Of Cyberbullying [Relevance Index: 4]	~
Detect And Identify Online Risks And Threats That Need The Assistance Of An Adult And Ask For Help [Relevance Inder: 2]	· · · · · · · · · · · · · · · · · · ·
Understand Online Etiquette And Behaviour [Relevance Index: 2]	· · · · · · · · · · · · · · · · · · ·

Figure 1: SCK Ontology Explorer Tool - Query results for topic related searches

By clicking on one of the available results, the tool will return to the user a graph, dynamically created on the spot, containing the competence in question, its relation to the knowledge object intercepted by the query, and the whole circle of knowledge elements in direct relation to it. To further facilitate the understanding and reading of this graph, the elements are colour coded according to the knowledge element category: Competencies are indicated in green, Threats in yellow, Proactive Strategies and Reactive Strategies in light blue, SCK Subdomains in pink, Core Concepts in grey, Negative Outcome in orange, Vocabulary in violet, Skills in brown and Competency Referential in teal. Collections of items are also colour-coded with specific colours: purple for collections of strategies and red for collections of negative outcomes.

Use Strategies To Protect Against And Prevent Cyberbullying [Relevance Index: 8]	^
Use Strategies To Protect Against And Prevent Cyberbullying has Knowledge Part Cyberbullying Protection Strategies include proactive strategy Cyberbullying Protection Strategies include proactive strategy Collaborate With Parents	

Figure 2: SCK Ontology Explorer Tool - Dynamically created graph based on one of the search results

This initial subset of elements is easy to understand and represents an ideal starting point for gradual exploration of the knowledge network. The tool developed in fact allows at this point both to obtain the details characterising the knowledge element and included within the ontology, and to add a ring of relations starting from any of the knowledge elements present within the graph.



Figure 3: SCK Ontology Explorer Tool – Detail view of a knowledge element

At this point, the user acquires the ability to explore in a gradual, autonomous and simplified manner all the knowledge present in the ontology and related to the topics he or she is interested in.

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Figure 4: SCK Ontology Explorer Tool – An expanded knowledge graph

## 4 Mapping existing games with the SuperCyberKids Learning Framework

This section proposes a general strategy for evaluating and designing the content of serious games. Specific measures are then introduced to show how the SuperCyberKids Learning Framework (a.k.a. SCKL Framework) can serve as a useful basis for comparison.

# 4.1 General approach and recommendation for the evaluation of game content

Serious games are becoming increasingly popular and are being used in a wide variety of educational contexts. There is a wide range for the use of serious games, for instance, financial education (Hoseiny & Niknafs, 2020), the medical field (Roman et al., 2020), cultural safety training (Pimentel et al., 2022), and cybersecurity (Manganello et al., 2023). In general, serious games as an intervention appear to be well-researched in terms of cognitive, metacognitive, and affective-motivational learning outcomes (Eseryel et al., 2014; Barz et al., 2024), as well as their influence on motivation (Zou et al., 2021), engagement, emotions (Lei et al., 2022), and potential in assessment (Eseryel et al., 2014). But there are still some challenges left: on the one hand, the competencies to be taught are not always clear and, on the other hand, how to integrate existing games into a curriculum (Wastiau et al., 2009). What often emerges is that the origin of the content and the conception of such games are not always transparent (e.g., Duffull & Peterson, 2020; Sousa & Rocha, 2019).

For this reason, we have developed a general strategy for evaluating the content and theoretical learning offered in serious games, with a focus on cybersecurity games. Later, we created a specific implementation proposal that considered the SCKL framework, which we also tested. To create such content evaluation strategy, we first conducted a scoping review to adapt or develop a suitable method. The review explores several key questions related to the development and validation of content for serious games. First, it examines whether there are standard processes for creating the content of such games. Additionally, it investigates the content validation strategies that are commonly used in connection with serious games. Beyond this, the review aims to identify the necessary components and processes required to develop and implement a holistic model for content validation in the context of serious games, with the focus on cybersecurity games.

To answer the given key questions, we utilized leading databases out of the areas of education, psychology, and informatics (Science Direct, ERIC, Web of Science, and IEEE Xplore). Our search included scientific literature published by June 2024 and was confined to articles that were published within the last five years. In sum, N = 181 studies were identified. After removing the duplicate, N = 148 were left. After carrying out the title and abstract search, N = 50 remained. After screening the full-text papers, N = 18 articles were finally included. From the included studies, we extracted the type of games, content analysis strategies that were carried out, and the criteria to develop the content of the games. Figure 1 provides a detailed overview of the scoping review.



Figure 5: Flow-chart scoping review

Initially, the purpose was to review existing strategies for content evaluation and, if appropriate, adapt them. Two different approaches were of particular interest: standard processes in the creation of serious games and validation strategies for the content of serious games. In terms of content development, three main application areas emerged. These range from utilizing experiential knowledge from experts (Arboleya-Garcia & Miralles, 2022; Andreoli et al., 2017), to leveraging scientific literature (Tinôco et al., 2022; Roman et al., 2020; Hodges et al., 2021; Neuwelt & Kearns, 2021), and employing multilevel methods (Ingadottir et al., 2022; Leong et al., 2021; Pimentel et al., 2022). Multilevel methods typically combine empirical knowledge and domain-specific expertise from professionals enriched by relevant literature. Notably, these approaches occasionally involve end-users in the process (Leong et al., 2021; Pimentel et al., 2022). Holistic content creation approaches also stress the importance of involving domain and content experts (Andreoli et al., 2017). Sometimes, the approach is reversed, with the development of serious games themselves contributing to learning outcomes (Ke, 2014). Additionally, the formulation of learning objectives by subject-matter experts (SMEs) has emerged as a method for developing content for serious games (Arboleya-Garcia & Miralles, 2022). An extension of this method could involve integrating serious games into curricula, using existing learning objectives (Duffull & Peterson, 2020; Hodges et al., 2021). A similar picture emerges for the content validation strategies of serious games. The evaluation process should involve different stakeholders, such as content experts, pedagogical experts, game designers, and developers (Andreoli et al., 2017). Additionally, questionnaires are one of the main methods for evaluating content (Calderón & Ruiz, 2015; Sousa & Rocha, 2019; Mhadhbi et al., 2024), but interviews and participant reflections are also frequently used (Pimentel et al., 2022). Dedicated questionnaires on content topics are rare, and content validation questions often appear only sporadically (e.g., Mhadhbi et al., 2024). These questionnaires tend to focus on a holistic evaluation of the games, frequently neglecting content validation. These findings are consistent with the results of the scoping review by Pistono and colleagues (2022), who identified eleven frameworks for creating and

validating serious games. The evaluation tends to focus more on design. These findings are consistent with this scoping review and support the inclusion of a comprehensive and well-validated basis such as the SCKL framework. Some authors tend to conduct usability tests, for example, for age appropriateness (Ingadottir et al., 2022) or in terms of design and gameplay (Leong et al., 2021), and consider elements of content evaluation (Daoudi, 2022). Andreoli and colleagues (2017) propose a more content-based evaluation through pre- and post-tests to measure learning gains (Calderón & Ruiz, 2015). Several options have emerged: one option is to compare with the learning objectives as part of a pilot study (Arboleya-Garcia & Miralles, 2022), and another is a validation carried out in advance by experts. For example, Neuwelt and Kearns (2021) had a validation carried out by experts before the introduction of their escape room. Another method is to have certain materials, such as practice-oriented use cases, evaluated by experts. In the study by Tinôco and colleagues (2022), experts validated the clinical cases, with a minimum agreement of 80% required. If this was not achieved, the use cases were adjusted.

In summary, we haven't found during the scoping review a holistic model for content evaluation. For that reason, we summarized the different steps and created an initial model for the content evaluation, which is displayed in figure 2.



Figure 6: Initial content evaluation framework for serious games

Basically, it can be divided into three phases or steps: initialization phase, theoretical content validation, and practical content validation. In the initialization phase for the validation of the content of the games, learning objectives for comparison should first be defined or extracted. These objectives can be created by SMEs (e.g., Arboleya-Garcia & Miralles, 2022; Andreoli et al., 2017), from scientific literature (e.g., Tinôco et al., 2022; Roman et al., 2020; Hodges et al., 2021; Neuwelt & Kearns, 2021) and/or from curricular learning objectives (Andreoli et al., 2017). In the second phase, a first content validation could be carried out. This first validation should check whether a serious game is theoretically available to achieve the learning objectives. This could be done by professionals in different ways, for instance piloting with professionals (Neuwelt and Kearns, 2021), interviews or reflection from professionals (Pimentel et al., 2022), or surveying professionals (e.g., Calderón & Ruiz, 2015; Sousa & Rocha, 2019;

Mhadhbi et al., 2024; Duffull & Peterson, 2020). In the third phase, the practical content validation, the end users should also be involved (e.g., Leong et al., 2021; Pimentel et al., 2022). Here, a pre-and post-test could be used to evaluate whether the content can be taught (Calderón & Ruiz, 2015).

In summary, it can be said that the content should be evaluated on an extensive and well-validated basis. To provide game designers and evaluators in the field of cybersecurity with such support, we suggest incorporating the SCKL framework. A specific implementation proposal is presented in the following chapter.

# 4.2 Exemplary proposal for the concrete implementation of the strategy by using the SCKL Framework

#### 4.2.1 Initialization phase

In the initialization phase, especially within the field of cybersecurity, we recommend using the SCKL Framework developed in WP2.1, along with the associated ontology, as the foundation for creating or the content evaluation of serious games. This framework offers a comprehensive and well-validated approach that can be applied both to the evaluation and creation of serious games.

In addition to individual skills from the SCKL framework, predefined competency statements from the ontology can be utilized. If needed, these can also guide the creation of specific learning objectives. A key advantage of using this framework is its flexibility: for those who don't require full coverage, it allows the extraction of specific areas or competencies. This means game designers can focus on a particular domain, such as malicious code, fraud, or data privacy, by filtering out relevant competencies from the SCKL framework. To support this phase, it is possible to use the tool described in section 3.

#### 4.2.2 Theoretical content evaluation

To ensure that the content implemented in the game corresponds to the targeted competencies, we recommend using one or more methods of theoretical content evaluation. It would make sense to combine different approaches. For example, the developed games or just their content could be passed on to experts and then evaluated using a survey. The focus here is on whether the individual topics can be achieved by the players in theory. A questionnaire that checks whether the competencies defined in the initialization phase can be achieved would be an effective instrument here. For analytical reasons and for practical testing, we recommend a questionnaire with at least a 5-point Likert scale.

#### 4.2.3 Practical content evaluation

In order to validate whether the content conveyed in the game promotes the desired skills in practice, the end users should be actively involved in the evaluation. To do this, pre- and post-tests are particularly useful for measuring the increase in knowledge and skills development among players. The pre-test assesses the level of knowledge and skills before the game begins, while the post-test is conducted after the game to evaluate the change in terms of acquired knowledge and practical skills. In addition, goal-based scenarios could be used in the game, in which players have to complete specific tasks or solve problems that are clearly aligned with the skills taught in the game. These scenarios provide a practical opportunity to apply the acquired knowledge in realistic contexts and to practically review the learning objectives. Combining pre- and post-tests with such scenario-based tasks enables a more comprehensive measurement of whether the intended learning objectives are successfully achieved. To address this, we developed both a pre-test and a post-test derived from the competencies outlined in the SCKL framework/ontology. We meticulously extracted all the necessary competencies to cover the relevant modules and created corresponding cases. These cases were subsequently evaluated by ten education

professionals and translated into four languages. Game designers can utilize the personalized needs identified within these individual cases to effectively measure the learning progress of the end users.

After the pilot phase, additional mechanisms and learning analytics could be used for continuous improvement.

# 5 Guidelines for game designers: a competence-based approach to designing new serious games

This section presents guidelines for competence-based game design. The process of formulating a successful learning game begins with the selection of a subject to address. The selection of abilities to emphasize enables a precise delineation of the knowledge domain the game will target, as well as the meticulous creation of the progressive acquisition pathway for the various talents.

However, we must make additional design decisions before building the game. An effective learning game design requires careful consideration of player engagement with the content, audience presentation of these features, and the game's intended context. Consequently, in the final section, we provide overarching guidelines that, when combined with those pertaining to competence-based design, enhance the framework for game designers.

#### 5.1 Competence-based guidelines for game design

The literature already provides cornerstones that any competence-based educational intervention should aspire to achieve (Levine and Patrick, 2019) and that find a natural and direct connection with the intrinsic characteristics of educational games: transparency, progress, assessment, agency, pacing, support, equity.

One of the most important and functional characteristics of competence-based educational contexts is in fact the absolute transparency of the objectives and the ways in which their achievement is evaluated. This clarity and transparency is actually already integral to the nature of games themselves: each game defines quite clearly the possible scores, what it means to win and what it means to lose, and what actions the player must take in order to achieve these goals. The unambiguity and clarity in the communication of this information is in fact one of the key elements in the design of educational games, together with the possibility of quantifying the results: the chance of creating confusion in the minds of the players shall be reduced to the minimum possible. In the competence-based context, in addition to making explicit the objectives to be achieved, it might be useful to show directly which competencies are being worked on and how they can be achieved through the game activities. Similarly, it is important to communicate to the player in a timely manner how the verification of mastery achievement in one of these competences will be carried out by the game. Achieving clear communication of objectives, rules, outcomes, measures and goals will not only facilitate the learning pathway but will also contribute to decreasing player frustration and increasing understanding of the cause-effect chains within the game.

In competence-based interventions, emphasis is placed on student advancement determined by mastery evidence rather than only time spent in class. Players of competence-based Serious Games should progress between levels by completing designated activities, rather than solely based on the duration spent on a particular level. Time can still be a limiting factor, especially depending on the context of the educational intervention, but its limitations within levels should be as much as possible associated with the fulfilment of particular tasks or the attainment of designated objectives. This form of temporal limitation is frequently associated with the exhibition of proficiency, as it enables players to actively interact with the game mechanics and showcase their skill.

With regards to the assessment, competence-based intervention usually exploits it as a mechanism that can convert the evidence generated by the student into an enriching educational experience. It is a period during which students obtain official feedback concerning their performance and mastery of competencies. This input is crucial for validating expectations, identifying areas for further investment, and formulating an action plan for the consolidation of their competencies. For this to occur, the evaluation must be clear and elucidative. Numerous games offer performance feedback to players at the

conclusion of different stages using a scoring system, frequently contextualized within a reference scale (e.g., granting three out of five stars). Nonetheless, the feedback must include the criteria employed in the assessment in order to be clearly understandable. Moreover, the timing of player evaluation significantly influences the outcome. Numerous games offer a performance assessment at the conclusion of a level; however, this should be accompanied by a brief "pause" in the gameplay to facilitate the player's reflective process and prevent disruption of the flow. Nevertheless, the continuous availability of feedback might assist the learner in readjusting their focus, gauging their advancement, and reassessing their tactics. To optimize the educational efficacy of the evaluation, it is essential to define and convey to the player at the outset of the game level the criteria by which they will thereafter be evaluated. This will clarify the objectives of the level and enable the player to focus their efforts and attention more judiciously. Likewise, virtual tokens (such as badges and awards) should be paired with in-game milestones to incentivize players and showcase their proficiency. Facilitating platforms for viewing assessments conducted in the game can aid in the integration of Serious Games-based interventions into conventional educational programs, thereby augmenting the role of educators and transforming them into active participants in the process.

Student agency is another crucial notion in competency-based education as it positions students as the primary actors in the learning process. The fundamental concept pertaining to the comprehension of agency is the significance of meaningful decisions: the choices of the agents must carry appropriate weight and result in tangible repercussions, both positive and negative. The Serious Game must provide the potential for decision-making, manifested through available options and choices, allowing the player to make selections autonomously and with conviction, even if such choices result in adverse outcomes.

With regards to personalization of the learning path, Serious Games have numerous benefits compared to conventional educational paradigms, including adaptive learning, individualized assistance, and equity. These games enable each learner to advance autonomously, tailored to their individual skills, knowledge, and learning aptitude. The capability to save game states, pause sessions, and continue them effortlessly at a later time enables students to halt gameplay without forfeiting progress, affording them considerable autonomy in structuring their learning. To further empower students, competence-based Serious Games can and should provide a comprehensive overview of their overall progress, elucidating any dependencies or foundational ties among the several situations and pathways they provide. Moreover, the educational games that envision a more structured context of play (e.g., the classroom) should provide ways for educators to offer tailored assistance to players by delivering targeted feedback via virtual companions and other non-player characters, which can be automatically processed after a clear evaluation of the players' performance and decisions. Within the framework of interventions aimed at integrating with conventional educational practices, a Serious Game can facilitate direct communication channels with educators, either synchronously (e.g., initiating a private chat) or asynchronously (e.g., through a ticketing system).

Equity is equally important in competency-based education and the broader educational framework. All students possess the right to equitable access to educational interventions, and Serious Games can be readily configured to accommodate many languages and input modalities. The growing multicultural dynamics of classrooms and educational environments necessitate that, even within national initiatives in non-English speaking nations, the game must also be accessible in English. This reduces the likelihood of foreign students with challenges in the national language of the host country being marginalized. Moreover, to facilitate the use of a competency-based Serious Game beyond the educational environment, it is essential to build the game to operate effectively on suboptimal hardware. Performance factors, such as selecting high-res 3D virtual environments rather than 2D ones, are especially significant. The selection of the platform for the game's operation is also crucial, as smartphones and tablets represent most of digital devices available to students. Finally, minimum standards must be evaluated to

allow schools with outdated equipment – the most common situation –to engage in activities aimed at enhancing school infrastructure and the game's reach.

#### 5.2 General guidelines for game design

#### 5.2.1 Type of learning in the game

The type of learning game that is being designed will have an impact on the mechanics that will be appropriate for use in the game. A ludotextual analysis of cyber security learning games (Callaghan 2024) identified a conceptual design space and key features to the design of three different exemplars of learning games. The exemplars are games as 1. Practice spaces, 2. Message delivery systems or 3. Conceptual conversation starters.

#### 5.2.1.1 A game as a practice space.

An effective practice game seeks to build fluency and accuracy in the responses of the player to the challenges that the game presents. The player may be asked to engage quickly with the material and the lag between failure and retry is deliberately kept short. For an effective practice game, the skill that has been selected to be trained must be part of the core loop of the game. The in-game context of the skill must mirror the actual real-world usage of the skill as is practically possible. The trade off in this design is that it is more suited to discrete skills and processes that have well established solution pathway. It is not suited to the discussion of complex or wicked social problems as it emphasizes quick decisions not reflection.

#### 5.2.1.2 A game as a message delivery system

All games carry messages to their audience be they through the procedural rhetoric that is used or more explicit means. Message delivery games focus on introducing the content in an engaging and memorable way. The game play in these cases often takes a back seat to the accuracy of the information being conveyed. The primary design limitation of these games is that they limit the agency of the player, the players ability to make meaningful choices is curtailed to ensure that all players go through the same content.

#### 5.2.1.3 A game as a conceptual conversation starter

In contrast to games used as practice space the conceptual conversation starter is focused on getting players to reflect and think about the issues that the game presents. Many of these games have conversations and debates as key mechanics of the game. In general they can be presented in a more abstract manner as they seek to help people make connections between the materials presented and other concepts and ideas from outside of the game space. The primary design limitation of these games is that the require time for consideration of moves and reflection on choices, making the fast-decision-making process used in practice space games inappropriate.

Project No. 101087250 ("SCK") - D4.3 "Guidelines targeting game designers"



Figure 7: Conceptual design space for learning games

The three exemplar games can be placed into a design space as shown in figure 3. This can allow the designer to make decisions and to be aware of the limitations of the specific forms of game.

#### 5.2.2 Aesthetic and Genre considerations

There is an axiom in design that "design for everyone is design for no one" this is especially true for the design of serious games. While entertainment games have only one target audience, the eventual consumer, serious games have three primary stake holders with overlapping concerns. The educational administration and political groups, parents and finally and most importantly the player. The content and skills identified in the SCKLF will help to address some of the concerns of the first two groups. However these groups are not homogenous throughout a European context and an effort to understand them during the design process is essential. It is also essential to keep in mind how is the player going to play with the final game and how it is engaging them.

Persona design is recommended as a method of ensuring that the design is meeting the needs of the diverse stakeholders. For an overview on persona design see "The persona lifecycle: keeping people in mind throughout product design" (Pruitt & Adlin, 2006).

#### 5.2.2.1 Genre considerations

Certain genres are more popular than others in learning games. So point and click adventures with minigames are more popular than first person shooters. This is not because any one genre has inherently better learning characteristics than any other but because of political, social and pragmatic pressures. A genre should not be selected before the type of learning in the game is established and careful consideration of how this genre supports the learning objectives of the game.

#### 5.2.2.2 Age and content appropriateness

Any game that is going to be designed to be used in a classroom context must be careful in how it presents specific topics and to which age group these topics are presented. A number of issues should be taken into account.

Firstly, the persona design should allow the designer to ask if this material is truly appropriate for the age group or if it is likely to cause backlash. Topics like sex, violence and drugs are major considerations. However, representations of women, religions and LGBTQ+ may become issues in different EU states for different political reasons. This requires a careful consideration of the potential complaints that may reduce the ability for the game to be used.

Secondly, different platforms follow different rules in different countries. The age rating systems and content expectations vary from country to country and platforms implement them differently. It is also important to note that games dealing with difficult subjects (for example, bullying or helping children recognise sexual grooming) might need higher age ratings than the game makers intend. It might prove impossible to upload a game into a store or distribute it in certain countries to younger children, even if the content is supposed to be educational.

#### 5.2.2.3 Pan European Game Information (PEGI) rating system

A good starting point for the process is to review the guidelines as presented by PEGI. It is worth noting that for educational games it is better to design at an age range lower than the actual intended audience age. This will help to ensure that the game is not running the risk of receiving a higher than intended rating and making the project less viable.



Figure 8: PEGI game rating labels and categories

#### 5.2.3 Legal and ethical constraints on data gathering and privacy

Games designed to be used within the European union are subject to GDPR legislation if they gather any data on the user. Given that the age range for these games may often be below the standard age of consent to have their data stored or used (16 as defined by GDPR) parental consent must be gathered. Article 8 section 2 states *"The controller shall make reasonable efforts to verify in such cases that consent is given or authorised by the holder of parental responsibility over the child, taking into consideration available technology."* 

While it is not clear what the consideration of available technology means some effort must be shown to be in compliance with the legislation.

Careful consideration must be taken when considering what if any trace data of game play will be gathered, how the data will be stored and used as well as how it can be removed from the data set at the request of a parent or guardian. Specific types of trace data such as geolocation data or logs of chat conversations within the platform may place either the user at risk, or the designer under a legal obligation to produce this data under a subpoena.

Privacy statements are required to be easily accessible and written in simplified English. The types of data being tracked have to be explicitly stated and parental consent sought.

One of the often-stated selling points of serious games is their potential use as a form of stealth assessment. In which the users will be monitored during their use of the system and feedback or data analytics used to provide information to the teacher or school. If the game is being designed to fulfil this role there are some ethical considerations as well as the legal considerations listed above.

#### 5.2.4 Context of use

How a game is presented to an audience has an impact on how it is perceived and its utility. The context in which a game is to be used will have implications to the design. The constraints of the environment that it is going to be used in have to be considered early in the design process.

In general, serious or learning games have two separate contexts of use, being designed to be either engaged with inside the classroom or to be used externally to the classroom. Each of these use cases will have distinct design decisions and limitations that must be addressed. These can be categorized into technological limitations, time limitations and usability limitations.

#### 5.2.4.1 In the classroom

A full discussion of the interaction patterns between a player and a serious game is provided in wp3.1 section 8. this section aims to examine three key considerations for designers to be aware of when designing a game to be used inside a classroom.

#### 5.2.4.1.1 Technology limitations

While the use of VR headsets may be groundbreaking it is unlikely that the majority of the schools will have access to them. This can seriously limit the number of players that the game can work with. The same consideration must be applied to any system specific hardware or software that is used in the game. In general, it is worth remembering that the hardware available in schools is not likely to be the most up to date and so system requirements should be kept low.

One method that has been suggested is the use of HTML 5 compatible engines to run the games via the web browser. Careful consideration of the legal implications for this are needed as well as the stability of the internet in the target region of the game. If the internet is not stable then what options are provided to the teachers to deal with the issue. (Video walkthroughs of sections, supplementary materials etc.)

#### 5.2.4.1.2 Time limitations

How long is your game going to be? Can it be broken into levels or sessions?

The average class time is between 45 and 60 minutes. However, this must include time for classroom management tasks (calling the roll, settling students down, collecting homework etc.), setting up the game (getting everyone logged in, teaching how to navigate\play etc.), and the debriefing of play at the end of class. This time limitation means that the actual time that a student may have to engage with the game can be as low as 20 minutes. For this reason, the full game must be able to be broken down into distinct sessions with clear learning goals. (even freeform games like Minecraft can do this by having clear goals given to students before they engage with the game).

Practice games are especially suited to being broken down in this way as they normally are designed with a quick to play approach in mind. With message broadcasting games the key message has to be able to be delivered in the time frame outlined or it will lose its impact. Finally conceptual conversation starter games require more time in discussion and debrief than the other games so require concise gameplay.

#### 5.2.4.1.3 Usability limitations

Teachers have limited amounts of time to prepare for a class, and repeated effort is often seen as wasted effort. How quickly can a teacher or student get into the game play? Do you have a tutorial section? Is it skippable after the first time that it has been played? Does your game have a save feature to allow a teacher to load up a specific section of the game for a class or do they have to play through the game every time they wish to use a section?

#### 5.2.4.2 External game use

Serious or learning games that are meant to be used outside of the classroom either are assigned as homework assignments or expected to be engaged with voluntarily as supplemental materials. These still require a careful consideration of the design limitations

#### 5.2.4.2.1 Technology limitations

Access to technology is not uniform throughout the European union. Access to internet enabled devices is still limited in certain countries and socio-economic groups. This digital divide creates ethical and practical concerns for the designer. Care must be taken to establish that the country and socio-economic group that the game is going to be used with have access to the technology platform that is being used.

#### 5.2.4.2.2 Time limitations

While there is more time available with a game that is going to be used outside of the classroom, it is in competition with more activities than one to be used in the classroom. Students need to be encouraged to actively engage with the game. Long introduction scenes or being forced to replay tutorials can act as demotivators to engage with the game.

#### 5.2.4.2.3 Usability limitations

The usability questions for games designed to be used outside of the classroom tend to revolve around how the teacher can be sure that the game has been engaged with at all. If the game is going to use player trace data or monitor the play in some way the legal and ethical issues discussed in section 3.3 come into play. If the teacher is going to use some other form of assessment like a quiz on certain content in the game is it provided or do they have to make it themselves?

## 6 Guidelines for the production game-based educational activities

The adaptation, or "localization", of a curriculum is a process that enables educational programs to meet the specific needs, regulations, and cultural contexts of diverse learning environments while maintaining core educational standards. Localization involves selecting, modifying, or enhancing learning objectives, instructional strategies, and assessment methods to fit the unique conditions and requirements of the intended setting. This flexible approach not only aligns the curriculum with national or regional educational frameworks but also promotes more effective learning experiences that resonate with students' backgrounds and local demands.

To support curriculum designers in this task, the **Flexibility Table** (FT) offers a robust tool for systematically adapting lesson plans within a broader curriculum structure. By using the FT, existing lesson plans can be modified to fit specific contexts through a clear, structured framework. The key features of this table facilitate informed decision-making regarding which aspects of a curriculum need adjustment to achieve relevance and alignment with local goals.

More generally, the FT supports this broader perspective on curriculum adaptation by offering a comprehensive framework that enables curriculum designers to align educational activities with both local and pedagogical goals. Reflecting the SCK project's focus on adaptability, the FT not only addresses the requirements of localized learning but also extends beyond simple curriculum changes to support the pedagogical planning essential for effective game-based learning. The table provides structured fields to adapt core competencies and learning outcomes, assisting designers in making every lesson or activity relevant, appropriately challenging, and sensitive to the unique educational context of its application.

Aligned with the principles of competence-based education, the FT serves as a bridge between the theoretical framework underpinning the SCK project and the practical needs of educational planners and game designers. Each component of the table—whether setting appropriate learner age levels, identifying mandatory learning outcomes, or selecting teaching strategies—supports an approach where competence-based learning objectives can be mapped to game-based activities, thus reinforcing core cybersecurity skills in a structured yet adaptable format. This alignment ensures that the curriculum not only adheres to high educational standards but also remains contextually engaging for students aged 8 to 13.

Further, the FT's attributes, such as required pre-knowledge and teaching strategies, facilitate a more localized instructional design process by helping designers tailor activities that are culturally and contextually relevant. This feature aligns with the objective of this deliverable, which is to guide the creation of educational experiences that are tailored to the backgrounds and educational needs of students. As such, the FT is particularly valuable in adapting game-based learning activities, allowing designers to consider both the educational standards and local regulatory frameworks that might impact curriculum delivery.

Beyond curriculum design, the FT also aligns closely with the proposed methodology for game-based learning activities. In the second phase of the methodology, which focuses on creating context-specific learning activities from pre-mapped games, the FT provides a practical tool for organizing instructional details and planning localized teaching strategies. Its structured approach assists in the design and adaptation of learning activities, offering a clear pathway for instructional planning within the context of cybersecurity education.

Finally, by supporting the exploration and application of the SCKLF, the FT enables designers to leverage it not only as a reference framework but also as a guide for practical application. The table, when used

with the SCKLF ontology tool, turns theoretical competencies into measurable learning goals. This makes it easy to move from the framework to a classroom or gaming environment.

# 6.1 Detailed structure and application of the Flexibility Table for Curriculum adaptation in SuperCyberKids

The FT for the SuperCyberKids (SCK) project is structured to support the adaptation of a cybersecurity curriculum by aligning competencies with specific contextual attributes. It is organized into several sections, each providing essential data fields to assist curriculum designers in the localization process, from competency reference to specific teaching and assessment strategies.

- 1. **Competency and Knowledge Reference**. The first section, comprising items such as "\_01\_Competency Referential", "\_02\_Competence", "\_03\_Knowledge Part", "\_04\_Skill", and "\_05\_Learning Objectives", directly references the SCK Learning Framework. These elements define the core competencies and knowledge areas to be included in the curriculum, setting a foundational framework that guides the adaptation of each learning component to ensure consistency with overarching cybersecurity education goals.
- 2. Learner Age and Level of Study. The table specifies the "06\_Appropriate Learner Age Level" and "07\_Appropriate Level of Study", indicating the target age range and whether the competency is to be taught at a basic or advanced level. By outlining these attributes, the table allows designers to calibrate the curriculum's difficulty, ensuring that content is appropriate for the learners' developmental stage and prior knowledge.
- 3. Educational Standards and Compliance. Attributes such as "\_08\_Applicable Educational Standards & Policy" and "\_09\_Applicable Regulations and Compliance" address the need for alignment with local educational standards and regulatory requirements. This section ensures that the adapted curriculum not only fits into the local educational framework but also adheres to any mandatory compliance criteria, making it relevant and legally viable within specific national or regional contexts.
- 4. **Prerequisites and Learning Objectives**. Fields like "\_10\_Required Preknowledge" and "\_11\_Learning Objectives" offer guidance on necessary prior knowledge and the core objectives each lesson aims to achieve. These indicators help curriculum designers understand and scaffold the skills learners need before engaging with new content, allowing for a smoother progression through increasingly complex cybersecurity concepts.
- 5. **Timeframe and Teaching Strategies**. The "\_12\_Estimated Timeframe", "\_13\_Teaching Strategies" and "\_14\_Teaching Activities" fields provide crucial insights into the anticipated time required to reach each learning objective and suggest effective teaching approaches. For instance, teaching strategies are categorized by level (basic or advanced) and can include storytelling, collaborative activities, or project-based learning for advanced competencies, offering flexibility in delivery while maintaining targeted educational outcomes.
- 6. Assessment and Learning Resources. The table includes fields like "\_15\_Assessment Strategies" and "\_16\_Appropriate Learning Resources" to guide the selection of suitable assessment methods and resource materials. This section allows designers to choose assessments that align with the competency level, ranging from oral responses and quizzes at a basic level to written assignments and practical security vulnerability tests for advanced learning. Relevant resources, whether digital platforms or physical tools, are tailored to the age and level of learners, facilitating effective competency acquisition.

7. Local Adaptation. Lastly, "\_17\_Local Adaptation" provides specific recommendations for tailoring the curriculum to cultural, linguistic, or educational variations. This field is particularly valuable in helping implementers address unique local conditions that may affect content delivery, ensuring that the curriculum remains accessible and impactful for diverse learner populations.

By detailing each section, the FT serves as a comprehensive tool, guiding the adaptation of cybersecurity lesson plans and ensuring that each curriculum is both contextually appropriate and aligned with core educational objectives. An example of the FT is provided in the **Appendix 1** for reference.

#### 6.2 The Flexibility Table as a tool for Lesson Plan adaptation

The FT facilitates Lesson Plan adaptation by guiding curriculum designers through key aspects that ensure alignment with both core competencies and specific contextual needs. As a first step, designers might examine the learning outcomes (LOs) to distinguish between those that are mandatory and those marked as optional. This classification enables designers to focus on essential competencies while also considering the inclusion of optional LOs to enrich the curriculum according to local educational goals or priorities. This approach ensures that the foundational learning objectives remain consistent, while providing room for contextual customization.

In addition to determining the priority of each LO, the FT provides recommendations for instructional strategies that can be adapted based on available resources and teaching conditions. For example, while a lecture format may suit larger groups or theoretical content, group work or lab activities might be more effective in promoting active, hands-on learning experiences. The designer can thus select from suggested strategies to create a balanced mix that resonates with the specific needs and resources of the learning environment. This flexibility allows for a tailored educational experience that fosters engagement and supports diverse learning preferences.

The FT further suggests the level of study for each LO, allowing designers to adjust the curriculum complexity according to student needs. For instance, a basic level may be appropriate for introductory content or beginner students, while an advanced level can be applied where more in-depth understanding or prior knowledge is expected. By adapting the complexity of the lesson plan, designers can ensure that the curriculum is appropriately challenging and meets the proficiency level of the students, creating a coherent and progressive learning path that remains sensitive to local educational contexts.

In summary, the **Flexibility Table** serves as a comprehensive guide that supports the customization of lesson plans while maintaining coherence with broader curricular standards. By following the steps outlined within the table, designers can ensure that each adapted lesson plan not only meets local educational needs but also adheres to recognized educational frameworks, facilitating meaningful and contextually relevant learning experiences.

#### 6.2.1 Example Flexibility Table for Online Behavior Lesson Plan

The following example FT offers a structured approach to developing the Spoofy LP "Online Behavior", ensuring that each component aligns with core competencies, engages students through tailored strategies, and addresses local context where necessary.

FT Section	Attributes	Example Selection in FT
_01_Competency Referential	Source Framework	SCKLF
_02_Competence	Competencies within SCKLF	<ul> <li>Social skills in online behavior</li> <li>Understanding and responding to abusive content</li> </ul>
_03_Knowledge Part	Concepts and knowledge related to etiquette and netiquette	- Basic etiquette principles

FT Section	Attributes	Example Selection in FT
		- Recognizing and addressing online
		bullying
		- Recognizing when to seek help
_04_Skill	Skills to be developed	- Knowing appropriate online responses
		- Identifying online bullying behavior
		- Recognize situations to contact a trusted
05 Learning Objectives	Specific objectives tied to	adult (ST-M1)
	competencies	- Understand basics of online bullying
		and response actions (ST-M3)
_06_Appropriate Learner	Appropriate age range	Ages 8–10
Age Level		
_07_Appropriate Level of	Basic or advanced levels	Basic (introductory concepts in online
Study		behavior)
		Compliance with primary school internet
_08_Applicable Educational	Alignment with local/national	safety standards; integrates with cyber
Standards & Policy	education standards	safety and digital citizenship learning
		goals
_09_Applicable Regulations	Regulatory compliance and	Adheres to local guidelines on child
and Compliance	standards	internet safety, online behavior, and
		digital responsibility
_10_Required Preknowledge	Required background knowledge	None required, as this lesson introduces
		core concepts
	Objections and the second	- Recognize etiquette and netiquette
_11_Learning Objectives	objectives pursued through	Identify trusted adults for reporting
	activities	- Identify trusted adults for reporting
12 Estimated Timeframe	Approximate lesson duration	1 hour
		Think Dair Share discussions
13 Teaching Strategies	Suggested strategies for	Game based learning with interactive
_15_reaching strategies	instructional delivery	guidance
		- Classroom discussion on etiquette
14 Teaching Activities	Specific activities to achieve	- SPOOFY game play sessions focused
	objectives	on resolving behavior-related scenarios
		- Guided discussions to assess
15 Assessment Strategies	Evaluation methods for gauging	understanding
	learning outcomes	- In-game decision-making reflections
		- SPOOFY game with lesson materials
_16_Appropriate Learning	Resources to facilitate the lesson	- Whiteboard
Kesources		- Projector for shared visual content
		Tailor examples of "bad behavior" to
_17_Local Adaptation	Suggestions for cultural or	context; adapt trusted adult discussions to
_	contextual adjustments	local societal norms on cyber safety

#### 6.2.1.1.1 Explanation: From Flexibility Table to Lesson Plan

**Competency Reference and Learning Objectives.** The FT defines essential competencies around "Online Behavior" and "Understanding Abusive Content", guiding designers to include relevant objectives, such as recognizing when to contact a trusted adult or understanding cyberbullying. This leads directly to the LP's objectives, where students learn to recognize potentially harmful situations and appropriate responses (e.g., contacting an adult, handling bullying).

Learner Age Level and Level of Study. The FT specifies that this lesson targets children aged 8-10 and is at a "basic" study level, focusing on introducing etiquette and netiquette. Consequently, the LP employs

simple language, age-appropriate scenarios, and introductory concepts, such as differentiating between etiquette and netiquette, which align with this early learning stage.

**Pre-knowledge Requirements.** Since the FT notes no required prior knowledge, the LP starts with foundational topics like general etiquette before progressing to online behavior. The lesson gradually builds familiarity, starting with real-life examples before moving to online scenarios, ensuring accessibility for young students with little or no previous exposure to these topics.

**Teaching Strategies and Activities.** The FT's suggested strategies include Think-Pair-Share and interactive gameplay, leading to an LP structure that combines discussion and the SPOOFY game for engaging, hands-on learning. The LP uses interactive prompts and game-based learning activities to maintain engagement and reinforce the social skills needed for safe online behavior.

**Assessment Strategies.** The FT suggests assessment through guided discussion and in-game decision reflections. In the LP, this translates to class discussions, such as asking students to consider if certain responses are appropriate or role-playing appropriate online behaviors. These methods allow for formative assessment, helping teachers gauge understanding in real-time.

**Resources and Local Adaptation.** The FT indicates resources such as the SPOOFY game, a whiteboard, and a projector, aligning with the LP's requirement for classroom equipment and visual aids. The FT also notes potential adjustments for local context, which the LP implements by encouraging students to discuss "trusted adults" based on their own cultural context. Additionally, the LP can modify examples of "bad behavior" to reflect familiar situations in the students' environment, making the lesson more relatable and culturally sensitive.

#### 6.3 Guidelines to create supporting materials

Serious or learning games are a form of transmedia in which the game is only the tentpole artifact. The game may be at the centre of the learning, but it must have links to other resources and artifacts to strengthen the impact of it. An example of this in educational terms is the myriad materials that surround the book "Moby Dick". The study of the book can be supported by images, movies, and other activities to be used inside or outside the classroom. In addition, it has a community that can support a teacher in their efforts to use the materials. Learning games like Minecraft edu have been made much more successful by the creation of supporting materials and community engagement.

The availability of supporting materials and community accounts for 20% of the score of a learning game analysis as proposed by Katrin Becker in her book "choosing and using digital games in the classroom" (2017). However, this is an area that is often neglected in the design of learning games

The fact remains that teachers will be more likely to use and engage with the game if it also includes supporting materials. These can take a variety of forms from lesson plans, quizzes, and conversation prompts used in the classroom to video play throughs, game guides and a community which are available to help the teacher understand how to use the game.

#### 6.3.1 Community support for SCKLF designed games

One of the hardest struggles in game design is getting your game played by your audience. Community engagement and impact are major metrics for a project's success but are hard to achieve. The SuperCyberKids project provides a ready-built platform for community engagement with your game. By putting a link to your game on the project website you make it more likely for teachers to be able to find your game and use it in the classroom. The website also offers a space for the community to help in the building and sharing of resources.

#### 6.3.2 Video playthroughs \ Guides

It is very useful to create YouTube video playthroughs and guides. These can help teachers to find the content and not get stuck in the game. This especially important for teachers who may not be comfortable with completing games themselves. Practice style games that have unlock elements (you must complete a certain activity to access the next level) can be frustrating for teachers and students if they are unsure or unable to meet the skill level to progress. This can lead to game abandonment.

It is important however to remember that guides and playthroughs are there to support the user and help them not to replace game play.

#### 6.3.3 Lesson plans

The SCKLF provides learning outcomes and competency statements. When creating a lesson plan refer to the example in annex 2 and fill in the form given in the same annex. The first step is to select the module that matches with the game or part of the game that is being played. The next is to define the context in which the game will be used. Pay careful attention to any resources that are needed for the classroom eg. Internet access, projector system etc. The Module you have chosen will provide you with the intended learning outcomes place the appropriate ones into the objectives section of the lesson plan.

At this stage you are ready to fill in the lesson plan proper. In general, the lesson plan follows the pattern of Presentation, Practice and Production (PPP). The first column provides the name and type of activity The second column gives a projected amount of time that the activity will take. The third column goes into detail describing the activity giving specific examples of teacher speech and how the classroom is to be organized. The final column provides extra details that may help the teacher to navigate around your game and engage with it.

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## 8 Annex 1 – Flexibility Table

CATEGORY LABEL	CATEGORY ITEM	DESCRIPTION	SELECTABLE CLOSED VALUES	MODE
01_Competency Referential	From SuperCyberKids Learning Framework (SCKLF)			
_02_Competence	From SuperCyberKids Learning Framework (SCKLF)			
_03_Knowledge Part	From SuperCyberKids Learning Framework (SCKLF)			
_04_Skill	From SuperCyberKids Learning Framework (SCKLF)			
_05_Learning Objectives / Statements	From SuperCyberKids Learning Framework (SCKLF)			
_06_Appropriate learner age level	Appropriate learner age level	The most appropriate age range for developing the competency	8 years / 9 years / 10 years / 11 years / 12 years / 13 years	closed - multiple
_07_Appropriate level of study	Appropriate level of study	Whether the competence/skill/learning objective is considered - BASIC (for introductory learning and foundational skills) or - ADVANCED (for more in-depth study and higher- level thinking skills)	basic [B] / advanced [A]	closed - single
_08_Applicable Educational Standards & Policy	Applicable Educational Standards & Policy	any specific standards contained in existing reference curricula (national, regional or local) or that align with teaching of the competence [note: helps making localized and/or implemented curriculum relevant and in line with educational requirements]		open field
_09_Applicable regulations and compliance	Regulations & Compliance	Any educational regulations, legal standards or compliance issues that may affect teaching of the competency, taking into account the level of study and educational policy at national / regional / local level/s		open field

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_10_Required preknowledge / prerequisites	Required pre-knowledge / prerequisites	Any prior knowledge or skills learners need to have before attempting acquisition of the competency		multiple
_11_learning objectives	Preset learning objectives	Learning objectives that the educational action in question pursues		multiple
_12_estimated timeframe for reaching learning objectives	Estimated timeframe for attaining learning objectives and/or acquisition of competence/s	Time required for attaining learning objectives /competence (study hours, timetabled school hours/period)		single
_13_Teaching Strategies	Effective teaching strategies for attaining learning objectives	teaching strategies considered appropriate, effective & engaging for attaining learning objective at basic or advanced level	* See examples listed below for basic [B] & advanced [A] levels	multiple
_14_Teaching Activities	Effective teaching activities for attaining learning objectives	Specification of teaching activities considered appropriate, effective & engaging for attaining learning objectives.		open
_15_Assessment Strategies / Activities	suitable strategies / activities for learning outcome assessment	strategies / activities considered suitable & potentially effective for assessment of learning outcomes	* See examples listed below for basic [B] & advanced [A] levels	multiple
_16_Appropriate learning resources	Appropriate learning resources for attaining learning objectives	Appropriate learning resources for attaining learning objectives at appropriate level of study	Link/s field/s with open field for comment	multiple - open
_17_Local adaption	Indications for facilitating local adaption	Indications on how to tailor the curriculum and its integration to suit local contextual conditions, including cultural, linguistic, educational factors, etc.		open

To provide illustrative examples of how the Flexibility Table might be instantiated in curriculum format, Tables 2 and 3 below list potential descriptive values that may be assigned to two attributes in the Table, namely [\_13\_Teaching Strategies] and [\_14\_Assessment Strategies / Activities].

Examples of [_13_Teaching Strategies]			
BASIC LEVEL EXAMPLES	ADVANCED LEVEL EXAMPLES		
[B] Storytelling with visuals and interactive elements.	[A] Research projects on specific cybersecurity topics.		
[B] Collaborative class activities focused on digital literacy.	[A] Simulations and role-playing for understanding network		
[B] Problem-solving exercises using tangible examples.	security.		
[B] Role-playing to introduce online safety rules.			

[B] Creation of simple digital content to illustrate basic IT	[A] Advanced coding challenges that require logical
concepts.	reasoning.
[B] Beginner's coding exercises using block-based coding platforms.	[A] Peer-to-peer teaching sessions on complex digital privacy concepts.
[B] Digital game play	[A] Critical analysis and discussion of real-world cybersecurity case studies.
	[A] In-depth exploration of cybersecurity ethics and law.
	[A] Digital game play

Examples of [_14_Assessment Strategies / Activities]		
BASIC LEVEL EXAMPLES	ADVANCED LEVEL EXAMPLES	
[B] Oral responses to demonstrate understanding of digital safety rules.	[A] Written assignments or essays analysing cybersecurity case studies.	
[B] Interactive quizzes to assess knowledge of basic computer concepts.	[A] Projects that involve setting up basic network security measures.	
[B] Creation of posters or digital presentations to show comprehension of online behaviours.	[A] Presentations on research findings related to advanced cybersecurity topics.	
[B] Group discussions and peer feedback sessions to reinforce digital literacy concepts.	[A] Development of a digital portfolio to demonstrate a range of competencies in cybersecurity.	
[B] Simple, guided tasks on a computer or tablet to evaluate basic navigational skills.	[A] Practical assessments where students must detect and address security vulnerabilities.	
[B] Digital game play	[A] Digital game play	

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## 9 Annex 2 – Lesson plan Example and Form

#### SPOOFY: Lesson Plan example

#### **Online Behaviour**

Text: SPOOFY



#### Learning Context:

- Ages 8-10
- 10-25 students
- 1 hour

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- Location: classroom with projector or screen visible to all students
- Resources:
  - Internet-connected computer for instructor
  - SPOOFY game with lesson materials
  - Whiteboard
  - Paper and writing instruments for students

#### Objectives:

- Social Skill focus
  - o Online behavior
    - Stranger Danger
    - Understanding Abusive Content
- \_
- ST M1:Children will be able to recognise situations where they should contact a trusted adult
- ST M3:Children will know what action to take in case of cyber-bullying
- ST M3:Children will know the basics of online bullying;Children should know what action to take in case
  of cyber-bullying, both for themselves and for others

#### Lesson plan:

(NB! Many students will be used to watching other people play games online while still feeling like they are a participant. One technique video game streamers often use to include viewers in on-screen activities is to always

use the pronoun "we" instead of "I" when making decisions in game. "Where should we go next?" is far more inclusive of the audience than asking "Where should I go next?" Try using this speech pattern when working through the game together.)

Activity	Time	Details Learning G		Extras
Introduction	3-5 min	<ul><li>Indicate to class that the topic for the day is going to be about proper behavior.</li><li>Elicit one example of bad behavior to the board. Eg listening to music loudly in public.</li><li>Introduce vocabulary: etiquette, netiquette</li></ul>	Introduction of the lesson focus	:
Think pair share	10 min	Place the students in pairs and ask them to come up with more examples of bad behaviour online and in real life. Stds write the examples in a list. The teacher draws a T chart on the board with etiquette on one side netiquette on the other. Elicit examples to the board and place them in the correct column or in between for both	Personalization of the learning	
Game introduction	5 min	Teacher "so today we are going to play a game together in class. What examples on the board do you think we will find in the game?" If this is your first time playing <i>SPOOFY</i> with this class, you will want to explain the overarching goal of the game: to get the spaceship running again. You may explain this yourself or play through the short tutorial/explainer with the class. Draw S's attention to screen and navigate to the map icon, and then to the school yard level icon to begin the text.	Placing Game based learning within the context of the topic	Map icon: Level icon
Play game First issue	10 min	<ul><li>Issue 1:Navigate to the teacher to get an overview of your goal in the school: get all students into the classroom.</li><li>Navigate into the hallway.</li><li>Upon entering the hallway, draw attention to the unhappy crowd near the next classroom. Elicit reasons for their unhappiness as well as possible fixes.</li></ul>	Online Behavior - Basic etiquette	Note that a number of decorative items can be collected during the course of this game. Allow

		<ul> <li>(NB! Headphones to fix issue are in the room in which you started)</li> <li>(Follow guidance from students as much as possible, but also try to steer the class toward working solutions quickly in order to move on from the text in a timely manner.)</li> <li>Once the problem is solved, elicit whether this was an etiquette issue or a netiquette issue. Also draw attention to the fact that both groups are now smiling.</li> <li>If desired, discuss when/where headphones and speakers are appropriate. (+2-3 minutes)</li> </ul>		students to choose who should wear these items as the game progresses. This will encourage students to stay more engaged in the game even though they aren't playing themselves.
Play game Second issue	10 min	<ul> <li>Issue 2: Navigate back into the hallway to find the crying child</li> <li>Elicit reasons why he might be crying. Upon approaching, the answer will become more clear. (He appears to be looking for his bunny)</li> <li>Upon reading the issue, elicit what kind of issue this is: etiquette or netiquette.</li> <li>Allowing students to guide exploration at this point will help the class stay more engaged in the process. No clues can be found inside the school building at this time, so allow students to navigate outside once other options have been exhausted. (This free navigation will present clues for later puzzles to the more attentive students.)</li> <li>If time is short, you may guide navigation in a more direct path toward your goals.</li> <li>Once outside, avoid interacting with other characters quite yet (though students may note them down for later interactions), and find the bunny rabbit on the left side of the yard. Pick it up and head back inside to return it to the crying student.</li> <li>Child states that "other players are bullying them on the internet" and they "want to say something really mean to them in return."</li> </ul>	Primary goal: Online Behavior - Basic etiquette Reinforcement goals: Understanding Abusive Content - ST - Module 1: Children should be able to recognise situations where they should contact a trusted adult ST - Module 3: Children should know what action to take in case of cyber- bullying	

		<ul> <li>Upon reading the issue, elicit what kind of issue this is: etiquette or netiquette.</li> <li>Pause the game and elicit feedback from the class. Is this an appropriate response? <ul> <li>Collect a number of possible responses before clicking to continue</li> </ul> </li> <li>When the chat appears, discuss the possible answers and elicit the correct answer from the class.</li> <li>Before selecting the third (correct) option, elicit reasons as to why the other options are incorrect.</li> <li>Select the third option and discuss the ensuing conversation with the class.</li> </ul>	
Think Pair Share	10 min	<ul> <li>Place students into pairs "Have you ever experienced cyber bullying? Have you ever been a cyber bully? Tell your partner about it."</li> <li>Give the students 5 minutes to discuss while monitoring and providing support.</li> <li>Sharing: Elicit examples of cyberbullying students have experienced in their own lives, whether they were on the receiving end or not.</li> <li>Discuss what they did in those situations and if that was the appropriate response.</li> <li>Discuss what they should do next time.</li> <li>Focus on the concept of getting an adult to help. Have the pairs create a list of "trusted adults"</li> <li>Elicit the list to the board.</li> <li>Ask the students to think about who their trusted adults are in their lives to whom they may turn in situations like the one portrayed in the game.</li> </ul>	Primary goal: Online Behavior - Basic etiquetteReinforcement goals:Understanding Abusive Content - 

Review	5 min	Teacher: "Today we learned about Etiquette and Netiquette, what is the difference?" "Why is it important to behave online?"	Reinforcing the learning objectives	



#### Learning Context:

- Ages of students:
- Number of students in class:
- Length of class:
- Location:
- Resources:

-

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#### Objectives:

- Students will be able to:

Lesson plan:

Activity	Time	Details	Learning Goal	Extras
Intro	5 min			
Discussion				
Review				
Wrap-up				