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Enhance the Learning of SEN Children With Dynamic Content Annotations

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ABSTRACT

Communication is difficult for students who have little or no clear speech. Consequently, a range of communication systems, including symbols, pictures, or gestures, is used as an alternative to speech. Semantic web technology has had an impact in the educational field and offers the potential for greater engagement with a rich web of content. However, there is a considerable gap between semantic web research contributions in the field of mainstream education, and the research carried out with special educational needs (SEN). This research was conducted to show the impact of applying semantic annotation techniques in improving the engagement, concentration, and behaviour of children with special needs. This study follows a Design Science Research Methodology (DSRM). The findings present a novel approach to teaching children with various needs by introducing educational prototypes using different semantic annotation content in an educational website. A total of 23 educators approved to participate in this study. The findings from the in-school experiment indicated that annotated content using semantic annotations could have a significant impact on making the learning process more effective with better class management for students with special needs, including pupils with autistic spectrum disorders.

Keywords: Innovative semantic annotations, Design science research, Symbol-based communication, Special educational needs, Effective learning

INTRODUCTION

Semantic web technology promises several benefits for a web future, including education (Pahl & Holohan, 2009). Semantic web techniques have been applied in the education sector to retrieve relevant content and add semantic annotations to documents. However, studies in this area have not considered semantic annotations in preparing special needs learning resources, taking advantage of the symbol systems (Makaton, PECS, and Widgit), pictures, or sign language. Government statistics in 2020 have revealed that pupils with special educational needs and disabilities have risen for a third consecutive year (Snowdon, 2020). Special needs schools continue to rely heavily on manual methods using sign language, photos, symbol systems, and objects to develop speech and vocabulary (Davis & Florian, 2004). Hence, the demand for customized teaching and learning resources to benefit all students with useful lessons that meet each learner's individual needs (Gregory & Chapman, 2013). This new evolution of the web is called the "Semantic Web."

Table 1. Iteration steps: Input-output steps.

Steps	Method	Input	Output
1. Identify the problems and challenges	Literature review	Literature (current teaching methods, SEN issues, styles, and their teaching requirements).	Construct and model current SEN teaching resources with gaps and requirements.
2. Select the required tools to conduct the field study.	Literature review and interviews (Teaching staff)	Requirements Semantic annotation tools.	Select Amaya annotation editor and HTML for the web design
3. Select the annotation type	Experiment with Amaya and the HTML	Website with annotations	SEN Teaching Platform.
4. Evaluate the SENTP platform.	Interviews (Teaching staff)	SEN Teaching Platform	Evaluation findings.

The Semantic Web is an extension of the current traditional World Wide Web - adding semantic descriptions and ontologies (Berners-Lee et al., 2006). One benefit is that such characterization and modeling help provide additional meaning to the web content; making content machine-understandable (Berners-Lee et al., 2001). One such technology, semantic annotation tools, is starting to gain traction, with automatic annotation, semi-automatic, or more manual approaches. The approach is unique in that it teaches children to initiate communicative interactions within a social framework. (Bondy & Frost, 2001; Loong & Herbert, 2012; Roschelle et al., 2010; Tan & Pearce, 2012; Liu & Elms, 2019)(see Table 1). From literature, teaching with symbols requires an adequate number of trained staff and an understanding of the complexity of young peoples' disabilities and behavior. Teachers often feel overwhelmed in preparing class resources, where more than one resource may be needed to explain each thought (O'Brien, 2019). Students' behaviors and learning engagement are other significant problems in managing any group with special needs (Bulgren & Carta, 1992). Pupils with learning difficulties tend to be more off-task, receive more teacher attention, particularly for off-task behavior, ask fewer educational questions with shorter response times, and less feedback than other pupils (Norwich & Lewis, 2001).

There has been only limited research on the effects of resources presentation style on students' learning and their attitudes towards the learning materials (Jamet & Colliot, 2018; Chorianopoulos & Giannakos, 2013; Ilioudi et al., 2013). Thus, there is a great demand for the provision of a facility to annotate these resources (Wang, 2009).

This article examines applying semantic annotations techniques to the design of the learning resources using the most popular methods such as symbol communication systems and images. The connection between the current methods and the annotation techniques with different learning resources, allows students to understand the background concept of each learning

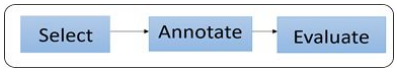

Figure 1: The SENTP model.

material by the linked metadata. This technique should facilitate the effective use of technology in SEN education.

RESEARCH DESIGN

Design Science Research (DSR) is now an accepted research paradigm in the Information Systems (IS) field, aiming at evolving determined IT artifacts and knowledge about the design of IT artifacts (vom Brocke et al., 2017). This study follows a Design Science Research Methodology (DSRM), a research process to discover a practical solution by evaluating the results in a set of iterations (Hevner et al., 2004; March & Smith, 1995). The solution effectiveness is demonstrated through an iterative evaluation of a designed artifact(s). Artifacts include constructs, models, methods, and instantiations (March & Smith, 1995). The process includes six steps: problem identification and motivation, the definition of the objectives for a solution, design and development, demonstration, evaluation, and communication (Peffers et al., 2007). According to Design Science research, each step applies a method to an input artifact and results in an output to use as input for the next step (See Figure 1).

This study aims to build and refine a number of micro- designs (content, annotation, process) each forming part of the SENTP. As components of the prototype framework are designed, built, and tested, they become building blocks that contribute to the platform. We started by designing a model and identifying the tools required (See Table 1). Each iteration step applies an input artefact method results in an output that could be utilised as input for the next iteration step.

CONCEPTUAL FRAMEWORK

Figure 2 defines the relevant variables for our study and maps out how they relate to each other. Based on the current teaching methods used to teach pupils with special needs. We will utilise the symbol communication systems, images, or text as annotation metadata.

To test the SEN teaching framework, we designed a poetry educational website. The website's content comprises different poetry styles selected from the national curriculum (2014), appropriate for age range (2 and a half-19 years). Although understanding poems is regarded as a challenging task for children with special needs as it can reflect emotions such as joy, sorrow, anger, which were difficult to understand for students with special needs. Also, understanding underlined meaning in poems is another challenge for children with Autism spectrum disorder (ASD) (Perko & McLaughlin, 2002). Another reason for selecting such materials for field testing is that poetry is motivating, entertaining, and ideal learning material for younger pupils

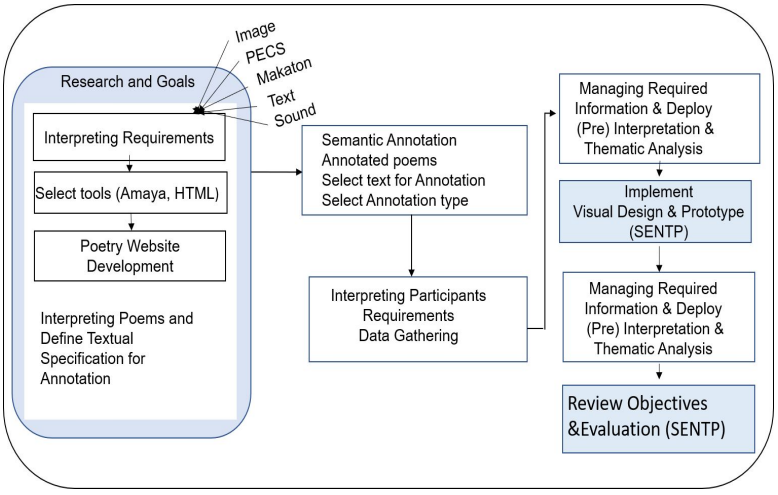

Figure 2: Conceptual SEN teaching framework.

(Smart, 2005). Besides, it allows the students to revisit and reuse critical concepts and vocabulary (City of Bradford MDC, 2016). The selected annotations can be represented as comments, images, notes, explanations, or other remarks that can be attached to a Web document (Amaya, 2015). The selection of annotation forms in the designed prototype is based on the literature review from some of the existing methods used in the UK schools.

IN-SCHOOL EXPERIMENT

We have created a prototype system that performs annotations with metadata for poetry sessions. The participants select the type of annotations, style, educational level, and the content of the poems based on the students' needs and age. We applied symbols as annotations from the symbol-based communication (Makaton, PECS, Widgit), pictures, text with bigger font size, text, or audio. Figure 3 depicts an example of the annotation dialogue displaying the annotation body area and the annotation metadata. The annotation body area employed a Makaton symbol ("scare"). This type of annotation can support communication for those with little or no speech development or literacy. Using such annotations could support language development for those with moderate to severe learning difficulties.

METHOD

Data Collection and Participant Selection

We collected the data from seven schools in the UK: two nursery schools (2 and a half-5 years; two special high schools (11-19 years); one state primary school (7-11 years); and one preschool for children with speech, language and communication difficulties (2 years and 9 months-4 years). A total of 23 educators approved to participate in the study. We audio-recorded and

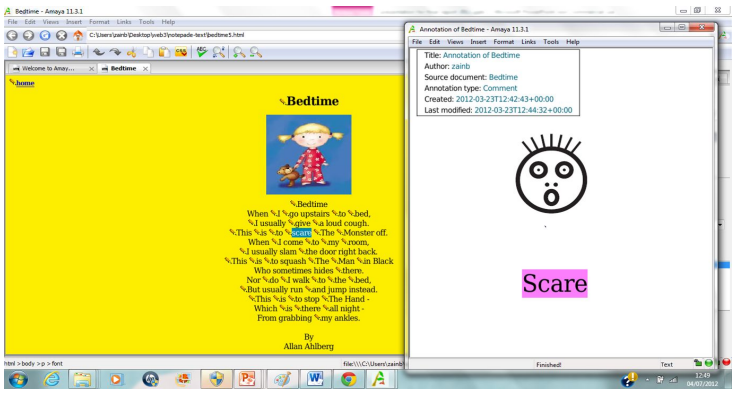

Figure 3: Annotated content "scare" with Makaton symbol.

transcribed the interviews. We prepared two types of questionnaires: pre-interview and post-interview questions. Also, we collected the data from the field notes and class observations.

Data Analyses

We classified the relevant data to each theme to ensure they connect with unique codes and the theme itself to conduct thematic analysis. Then, we presented a model of themes to show the connections and relationships between the themes and the subthemes based on Braun & Clarke (2006).

All the interviews' transcripts are thematically analyzed and used as part of the broader design process to elicit future requirements and, more importantly, to determine artifact effectiveness (Braun & Clarke, 2006). We utilised NVivo11 to facilitate analyzing the data and to determine significance (Zamawe, 2015).

RESULTS AND DISCUSSION

Looking at the results from the study, the participants expressed their current teaching concerns toward teaching children with SEN. The results show that twenty-one of the participants (91%) currently use manual resources to teach pupils with SEN, mostly visual. This result shows the amount of pressure to complete their routine work. It outlines the need to reduce this overloaded work from the teaching staff, especially when they are short of staff.

The findings shows that applying annotation techniques to the students resources could increase the students' engagement, encourage good behaviour and improve communication skills by utilising different types of annotation forms that related to each students' needs such as real images, symbol systems, and applying appropriate font and size. Furthermore, improving the students' understanding could reduce students' anxiety which can impact on improving students' behaviour. The participants highlighted some current concerns that have an impact on the student learning progress such as managing big groups, emotional language, behaviour problems, working independently, preparation time, vocabulary, and reading. The interview

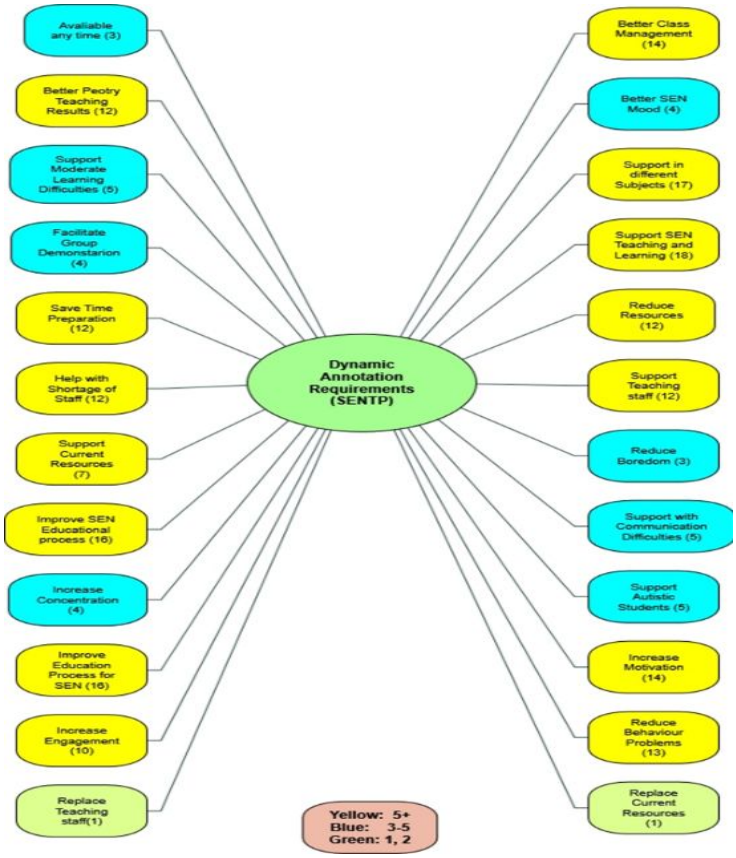

Figure 4: SENTP thematic evaluation results.

results show that SENTP has a positive impact and could provide good support during the teaching process. T8-M-PI considered the preparation time as one of the main concerns: "… I think preparation is an issue because it is just a time factor [...] our teaching assistants and teachers are very good at preparing additional resources for special needs children, but it is very time-consuming".

Dynamic annotations support autistic students who find text involving impressions, emotions, feelings, imaginative and figurative content difficult to understand without special visual aids. There was considerable agreement among participants across the teaching staff that teaching emotions, underlying meanings, and imagination are challenging for students with SEN. This concept was expressed by T8-M-P: "Poetry is about impressions, emotions, and feelings. The thing that they find particularly challenging is emotions, feelings, and inference. The inference is very tricky for them". TA8-M-SMO believed that using such digital annotations with the learning resources could enhance the learning process for children with a physical disability.

CONCLUSION

We investigated the impact of dynamic semantic annotations using symbol communication systems (Makaton, Widgit, and PECS), pictures, or audio.

We designed an educational poetry website for a range of age groups. Then, we selected an appropriate annotation editor to test the SENTP prototype. Design science research (DSR) methodology directed the SENTP artifacts, including the construct, model, method, and instantiation. The artifacts included applying communication symbols (construct). Then, interviewed educators and reviewed literature (method).

The final results show that classrooms could benefit from reduced behavioral problems and increased students' understanding to achieve better class management. Teaching with such learning resources could support the educators with the routine lesson preparations. There is a clear need to investigate with a wider data collection approach to avoid any bias that could occur during the interviews.

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