Towards Caring for Digital Wellbeing with the Support of Learning Analytics

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Resumen: Este artículo describe tres estudios que analizan el impacto de las tecnologías del aprendizaje en el bienestar, así como el papel que las Analíticas del Aprendizaje pueden desempeñar en la medición y mejora de dicho impacto. Para empezar, diez investigadores españoles utilizaron las métricas de bienestar IEEE P7010 para analizar el impacto de sus productos en el bienestar. También respondieron a encuestas previas y posteriores para evaluar el impacto del ejercicio en su capacidad para desbloquear el potencial de sus herramientas para promover el bienestar. Posteriormente, 68 maestros saudíes participaron en una sesión en línea y completaron una encuesta sobre una de las tecnologías bajo investigación. Finalmente, los investigadores participaron en un taller de co-diseño para proponer escenarios de Analíticas del Aprendizaje para cuantificar el impacto de ciertos aspectos del bienestar. A pesar de los diferentes contextos, objetivos y usuarios de las herramientas exploradas en este documento, se identificaron posibles impactos en todo el espectro del bienestar. Argumentamos que el uso de las Analíticas del Aprendizaje puede ayudar considerablemente a cuantificar la medición de los elementos de bienestar tanto dentro como fuera de los entornos de aprendizaje, hecho que permite que el impacto en el bienestar se revise y mejore constantemente.
Palabras clave: Bienestar, Analíticas del Aprendizaje, Diseño del Aprendizaje, Ética, Valores

Abstract: This article describes three studies that looked into the impact of learning technologies on wellbeing, as well as the role that Learning Analytics can play in measuring and enhancing such an impact. To begin, ten Spanish researchers used the IEEE P7010 wellbeing metrics to analyse their products' wellbeing impact. They also responded to pre- and post-surveys to assess the exercise's impact on their ability to unlock the potential of their tools to promote wellbeing. Then 68 Saudi teachers participated in an online session and completed a survey regarding one of the technologies under investigation. Finally, the researchers participated in a co-design workshop to propose learning analytics scenarios for quantifying the impact on certain aspects of wellbeing. Despite the different contexts, goals, and users of the tools explored in this paper, possible impacts across the full spectrum of wellbeing were identified. We argue that using

Learning Analytics can considerably help in quantifying the measurement of wellbeing elements both within and outside of learning settings, allowing the wellbeing impact to be constantly reviewed and enhanced.
Key words: Wellbeing, Learning Analytics, Learning Design, Ethics, Values

1. Introduction

The world of information is today mediated by digital technologies where the growing involvement of data analytics and Artificial Intelligence (AI) in everyday life is likely to present issues with lasting consequences. The individual and societal wellbeing is becoming intimately connected with the state of our information environment and the digital technologies that underpin our life experiences (Burr, Taddeo & Floridi, 2020). The global efforts toward evaluating and enhancing the impact of such technologies on wellbeing continue to establish guidelines and metrics for such systems to remain human-centric, serving humanity's values and ethical principles. These efforts include two recent reports by the Institute of Electrical and Electronics Engineers (IEEE) under the umbrella of the IEEE global initiative on Ethics of Autonomous and Intelligent Systems (A/IS), providing guidance to wellbeing researchers as well as those creating and using automated data analytics and AI solutions (Musikanski, 2020).These two productions of the A/IS initiative consist in a publication entitled "Ethically Aligned Design" (EAD) (IEEE, 2019), and a standard entitled "P7010–2020 Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Wellbeing" (IEEE, 2020). The IEEE aims at establishing wellbeing metrics to enable technologists to better consider how the products and services they create can enhance human wellbeing based on a wider spectrum of measures than growth and productivity alone (IEEE, 2020).

AI methods and algorithms are becoming more involved in how decisions are made in public and private life. The presence of this shift in the field of education is represented by the data collection and management of learners' data for the purpose of understanding and optimizing learning. Consequently, the collection and use of educational data pose a range of ethical issues, including the location and analysis of data; informed consent, privacy and de-identification of data; and the classification and management of data (Slade & Prinsloo, 2013; Kimmons, 2021; Beardsley, Santos, Hernández-Leo & Michos, 2019). Other ethical questions being tackled by researchers in the field of Learning Analytics (LA) raise thorny questions about how and what data are dealt with in educational environments and extend to societal topics like transparency, trust, fairness, accountability, and social wellbeing (Drachsler & Greller, 2016; Buckingham Shum, 2017; Gardner, Brooks & Baker, 2019; Chen & Zhu, 2019; Alwahaby, Cukurova Papamitsiou & Giannakos, 2021). However, there is a research gap in considering the potential of LA to impact the wellbeing of learners and teachers from a holistic perspective in ways that go beyond enhancing learning outcomes.

In this paper, we apply an assessment process consisting of three studies (Table 1) guided by the IEEE P7010 wellbeing metrics (IEEE, 2020) to a set of LA-supported educational technologies to answer the following questions:

RQ1: Where and how can LA-supported educational technologies impact on wellbeing?
RQ2: To what extent does the use of IEEE P7010 increase the awareness of educational technologists about their tools' wellbeing impact?
RQ3: How can Learning Analytics be extended to measure wellbeing elements?

	RQ	Activity	Participants
Study 1	1, 2	Pre survey, Internal analysis, Post survey	LA researchers n=10
Study 2	1	Online tutorial, Survey	Teachers n=68
Study 3	3	Co-design workshop	LA researchers n=10

Table 1: Research design of studies

First, ten Spanish LA researchers belonging to the Spanish Network of Learning Analytics (SNOLA) were engaged in an internal analysis process to initially identify where and how their tools may impact wellbeing. They did so by selecting wellbeing instruments already in use and have been proven to be an accurately measurement instrument (i.e., scientifically valid) to reflect the wellbeing impact of their tools. They also responded to pre and post questionnaires to evaluate how this activity could help them realise the potential of their tools to impact wellbeing. In the second study, 68 Saudi teachers attended an online tutorial session about one of the studied tools and reflected on the wellbeing indicators selected by the LA researcher who developed it. Finally, the LA researchers participated in a co-design workshop to identify data sources and analytical techniques that can help measure the impact on a given wellbeing aspect.

The rest of this paper starts with a brief review on the ethics of digital wellbeing and their implications in the field of LA. Then we explain the IEEE P7010 Recommended Practice for Wellbeing Impact Assessment and how it can be used to safeguard wellbeing in data-driven digital spaces. Afterwards we present the methods and findings of each study and conclude the paper by an overall discussion on the three studies and the promises and challenges of using LA to measure and enhance wellbeing.

2. Ethics of Digital Wellbeing

Since their first advent, digital technologies have been connected to ethical questions and concerns about their impact on people's lives and the wellbeing of individuals and communities. The expression "digital wellbeing" is used to refer to the impact of digital technologies on what it means to live a life that is good (Floridi, 2014). Wellbeing refers to what is directly or ultimately good for a person or population, and it is not limited to one or two dimensions, but rather encompasses the full spectrum of personal, social, and environmental factors that enhance human life and on which human life depends (IEEE, 2019).

To the extent that data analytics and AI techniques add to digital technologies in terms of capability and impact, they add a heavy burden of ethical concerns that are more crucial than ever before. The field of education was like many other sectors affected by the increasing use of digital technologies and thus by the technological pathways opened by the flow of data from such technologies. Big and small data techniques are being presented and used in the field of education in the form of Learning Analytics, which is defined as the processes of collection, measurement, analysis, and reporting of learners' data for the purpose of understanding and optimizing learning and the environment in which it occurs (Long & Siemens, 2011). As the use of LA has increased, a variety of ethical considerations have covered critical data-related issues like privacy and protection and have extended to other important societal values. However, a significant research gap remains in considering the potential of LA to impact the wellbeing of learners and teachers from a holistic perspective in ways that go beyond the learning aspects. A recent review on the theme of digital wellbeing by Burr, Taddeo & Floridi, (2020) highlights major issues related to four key domains, including education, where digital technologies have increasing roles and impact. The review referred to articles that had discussed, for example, how digital technologies could support lifelong learning and openness to new opportunities (Pedaste & Leijen, 2018); how gamification-based learning could improve cognitive skills (Karime, Hafdh, Khaldi, Aljaam & El Saddik, 2012); and how smartphones could automatically detect moods and help with work-life balance and management through increased awareness of stress and emotional understanding (Baras, Soares, Paulo & Barros, 2016).

2.1. IEEE P7010 Recommended Practice for Wellbeing Impact Assessment (WIA)

As a methodology, WIA consists of five activities: 1) Internal, user, and stakeholder analysis, 2) wellbeing indicators dashboard creation, 3) data collection plan and data collection, 4) wellbeing data analysis and use of wellbeing indicators data, and 5) Iteration. The focus of this paper is related to the first and third activities, where subjective and objective data are collected from the creators and the users of LA-supported technologies to investigate how the

digital wellbeing of these tools can be understood and measured.

The IEEE P7010 recommended practice provides 134 indicators drawn from wellbeing measurement instruments already in use and have been proven to be an accurately measurement instrument (i.e., scientifically valid) to be used to primarily assess the impacts of a wide range of data-driven technologies on each of the following wellbeing domains: life satisfaction, affect (feelings), psychological wellbeing, community, culture, education, economy, environment, government, health (physical and mental), human settlement, and work.

3. Methodology

We applied three connected studies to answer the three research questions of this paper (Table 1). First, ten Spanish LA researchers who have been involved in the creation processes of ten LA-supported educational tools and services participated in an internal analysis process for the purpose of identifying useful indicators that can reflect the wellbeing impact of each system. This task was conducted with the aim of increasing the participants' awareness of wellbeing domains and indicators, and therefore their capacity to address and evaluate the wellbeing impact of their systems. The participants responded to a short prequestionnaire and reflected on the usefulness of this internal analysis activity through a post questionnaire. Second, 68 teachers participated in an online tutorial and provided data on how a specific LA-supported tool, such as a learning design community platform may impact their wellbeing as users. Third, a co-design workshop was conducted with the LA experts to find out how to quantify the measurement of wellbeing through LA.

4. STUDY 1: LA Researchers' Views about the Wellbeing Impact of LA-supported Tools

This study was conducted by applying the first activity of the IEEE P7010 standard, initial internal analysis, to the creators of ten LA-supported educational tools and services that were in different stages of the design lifecycle. The task was conducted with the aim of increasing the participants' awareness of wellbeing domains and indicators, and therefore their capacity to address and evaluate the wellbeing impacts of their systems. This activity was carried out to answer the following questions about each tool involved in the study:

- What is the educational tool / service?
- What is the need it meets/ goal it seeks/ problem it solves?
- Who are the intended and unintended users and stakeholders?
- What are the possible impacts on human wellbeing? And what is the probability of their occurrence?

By answering the four questions above, the participants were expected to have both understanding and grasp on limits of understanding of how their systems may have positive and/or negative impacts on intended and unintended users and stakeholders.

4.1. Pre survey

Before conducting the internal analysis process, the LA experts were asked to complete a short qualitative survey to investigate their awareness about their tools' wellbeing impact before applying the IEEE P7010 internal analysis activity. They were requested to answer the following question:

- *Indicate a tool using learning analytics that you have designed or co-designed. Have you observed any positive or negative impact of your tool on the users' wellbeing? If there are any, please explain.*
  (Hakami and Hernández-Leo, 2021a)

4.2. Internal Analysis

The IEEE P7010 internal analysis process is designed to be conducted by the tools' creators alone and should involve forecasting, hypothesising, projecting, utilising scenarios, and other means of internal analysis (IEEE, 2020). The participants conducted this activity to answer the first question of this study through an online-based session that we held to present the materials of this activity, followed by asynchronous individual analysis and post-

activity survey. The WIA methodology provides a set of 134 indicators that measure 12 wellbeing domains (2-23 indicators per domain) within definitions of each domain and subdomain.

The activity was conducted in a manner where each participant was allowed to 1) identify the system's goals, users, and stakeholders, 2) read the definitions and indicators of each wellbeing domain and subdomain, 3) select indicators that reflect potential impacts of each tool on the wellbeing of its users, stakeholders, and the society; and 4) provide optional explanations and justifications about their indicator selections. This activity produced a group of indicators that initially identified the scope of wellbeing impact of the studied LA-supported educational technologies. Findings that are related to the eleventh tool in this study (Learning Design Community Platforms ILDE) are reproduced from (Hakami and Hernández-Leo, 2021b; Hakami and Hernández-Leo, 2021c).

4.3. Post Survey

After the participants completed the internal analysis activity, they were asked to fill a post Yes/No questionnaire to evaluate the usefulness of IEEE P7010 in increasing their awareness of their tools' wellbeing impact. They also were asked to provide further optional explanations on their answers. The questions were driven from the IEEE P7010 internal analysis checklist and were as follows:

- *Have possible impacts on wellbeing been identified?*
- *Were unintended and unexpected issues considered, such as potential biases and negative impacts, including how risks and negative impacts to human wellbeing can be mitigated?*
- *Has this activity increased your awareness of wellbeing domains and indicators that are relevant to your system?*
- *Has this activity increased your capacity to address and evaluate the impact of your system on wellbeing?*

(Hakami and Hernández-Leo, 2021a).

4.4. Findings

The LA researchers' responses to the pre activity question are presented in (Table 2). The LA researchers' descriptions for their tools' goals and users are explained in (Table 3). The findings of the internal analysis process are represented in (Table 4), where the twelve wellbeing domains are listed within the indicators selected by the participants to reflect the wellbeing impact of each tool.

	Indicate a tool using learning analytics that you have designed or co-designed. have you observed any positive or negative impact of your tool on the users' wellbeing? If there are any, please explain.
1	Positive: Reduction of cognitive load, stress and time consumption among users (instructors). Awakening of curiosity from data exploration and discovery.
2	This tool is useful to intervene in real time. So it has a positive impact on academic staff and, finally, students.
3	Our tool hasn't been tested yet with end users
4	It reduces their anxiety and increases their sense of fairness while we are assessing their activities in the group. They feel happier with this way of evaluating their work in a group
5	Some students become more involved and interested about their progress.
6	Sometimes it may create stress to the teachers, and feelings of reduced agency. Comparisons with others may be either beneficial or not.
7	I observed positive impacts in the fact that the teacher could rely on the tool to be aware of situations that s/he was not able to control "manual". The teacher understood the output perfectly (it was very simple). The teacher was in control, because it was her responsibility to decide what to do with the information given by the tool. The tool facilitated an email address to contact the student in an efficient way, if the teacher decided to do so after the information given by the tool.
8	The negative aspects can be related to the fact that it was necessary to do some extra work in advance, in the definition of the "teacher's pedagogical intention" so that the system could work.
9	We have not really tested well-being for the tool in detail
10	Yes, the learner'' performance was improved.

Table 2: LA researchers' responses to the pre activity question

LA Tools	**Description**
Dashboard Generator (DB)	A meta-modeling based approach that allows the generation of tailored dashboards including LA dashboards. **Users:** Any. **Other stakeholders:** Any
AdESMuS	System oriented to support users in complex assessment scenarios through different modules of visualization. **Users:** Teachers and learners. **Other stakeholders:** Academic managers
Glimpse	It is a system that uses teachers' pedagogical intention to set up rules that are checked against data collected from several sources of data, including self-reported data, VLEs and external tools. **Users:** Teachers. **Other stakeholders:** Learners
Early Warning System (EWS)	It is a web-based tool that provides information about possible learners in danger taking into account the interactions with an assessment supporting tool. **Users:** Teachers and learners. **Other stakeholders:** Academic managers
MWDEx	A system that facilitates the instructor's observation and analysis of peer assessment activities by downloading and preparing data from Moodle Workshops and offering visualization and analysis capabilities. **Users:** Teachers. **Other stakeholders:** Learners
Teacher Action Planner (TAP)	The TAP is aimed at providing an actionable dashboard for teachers to manage design and orchestration (or even design) of science inquiry activities that are carried out with the WISE system. **Users:** Teachers. **Other stakeholders:** Researchers, academic managers and learners
ANALYSE	A web-based tool that provides different dashboards about students' progress and students' activities with exercises and videos in the Open edX platform. **Users:** Teachers and learners **Other stakeholders:** Academic managers
RAC	A web-based tool integrated in the Virtual Campus where teachers introduce evaluation activities marks and provide personalized feedback. Students access this application in order to see the academic results. **Users:** Teachers and learners. **Other stakeholders:** Academic managers
Teamwork assessment of Telegram Messages (TATM)	An LA tool that gathers and presents the indicators relevant for the evaluation of students' individual acquisition of teamwork competence taking into account CTMTC methodology. **Users:** Teachers. **Other stakeholders:** School community members
edX-LIMS	edX-LIMS (acronym of System for Learning Intervention and its Monitoring for edX MOOCs) is a web-based Learning Analytics System that provides an intervention strategy on the learners' learning and the monitoring of the mentioned strategy by the instructors. Users: Stakeholders:
Learning Design Community Platforms (ILDE)[1]	Integrated lesson planning tools that support teachers in the creation, co-creation, and sharing of designs of learning activities. Teachers are also supported by data-driven systems that assist the lesson planning with data analytics **Users:** Teachers. **Other stakeholders:** Learners, academic managers, school community members

Table 3: Descriptions of the tools included in this study

[1]*Data related to ILDE is reproduced from (Hakami and Hernández-Leo, 2021b; Hakami and Hernández-Leo, 2021c).*

Impacted areas (wellbeing domains)	Selected indicators	Impacting systems
satisfaction with life	Sense that on''s life is the best to worst possible life for them at the time.	ANALYSE, TATM, ILDE
	How satisfied are you with your life nowadays?	AdESMuS, Glimpse, TAP, ANALYSE, TATM, ILDE
	Satisfaction with life as a whole.	DB, Glimpse, TAP, ANALYSE, TATM, ILDE
Affect	Positive affects: feeling happy, calm, peaceful.	DB, AdESMuS, Glimpse, EWS, MWDEx, ANALYSE, TATM, ILDE, edX-LIMS
	Negative affects: feeling sad, depressed, stressed anxious.	DB, Glimpse, EWS, ANALYSE, ILDE
Psychological wellbeing	Feeling that the things one does are worthwhile.	DB, AdESMuS, Glimpse, EWS, MWDEx, TAP, ANALYSE, ILDE
	Sense one is capable and good at what they do.	DB, AdESMuS, Glimpse, EWS, MWDEx, TAP, ANALYSE, TATM, ILDE, edX-LIMS
	Sense that one leads a purposeful and meaningful life.	DB, TAP, ANALYSE, TATM, ILDE
Community	Sense of belonging to a community.	DB, AdESMuS, Glimpse, EWS, TATM, ILDE, edX-LIMS
	Sense that if one were in trouble, they would have relatives or friends they can count on to help them whenever they need them, or not.	Glimpse, TAP, ILDE
	Sense that most people can be trusted or that one needs to be very careful in dealing with people.	Glimpse, TAP, ILDE, edX-LIMS
	Satisfaction with relationships.	TATM
	Sense of discrimination in one's neighbourhood or community in one's neighbourhood.	Glimpse, TAP, TATM
	Approximate total hours a month one was active in voluntary organizations.	ILDE
Culture	Engagement with / participation in arts or cultural activity.	ILDE
Education	Satisfaction with educational systems or schools in area in which one lives.	DB, AdESMuS, EWS, MWDEx, TAP, ANALYSE, RAC, TATM, ILDE, edX-LIMS
	Access to opportunities to learn.	DB, ANALYSE, RAC, ILDE, edX-LIMS
	Extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are part of teacher education; classroom curriculum and student assessment.	EWS, RAC, ILDE, edX-LIMS
	Average years of schooling.	DB, EWS, TAP, RAC, TATM
Economy	Degree to which one is worried about losing their job or not finding a job.	DB, ANALYSE, ILDE, edX-LIMS
	Unemployment rate, by sex, age and persons with disabilities.	DB, TAP, ANALYSE, edX-LIMS
	Income inequality or rich-poor gap or Gini index.	TAP, ANALYSE
Environment	Satisfaction with efforts to preserve the environment.	ILDE
	How much (people) know about global warming or climate change.	ILDE
Government	Satisfaction with one's last experience of public services.	EWS, ANALYSE, IDLE, edX-LIMS
	Laws, policies, and practices guarantee equal treatment of various segments of the population.	DB, ANALYSE, edX-LIMS
	Sense there is equality of opportunity and the absence of economic exploitation.	ANALYSE, edX-LIMS
	Sense there is freedom of assembly, demonstration, and open	ILDE, edX-LIMS

	public discussion.	
	Sense there is respect for individual human rights nowadays in one's country.	Glimpse, ANALYSE, ILDE
	Print, broadcast, and / or internet-based media are not directly or indirectly censored.	edX-LIMS
	Attendance of peaceful demonstrations in the last year.	edX-LIMS
	Sense of confidence in government -national, local, civil service, judicial system, police, political parties. etc.	edX-LIMS
	Sense that government is free from pervasive corruption.	edX-LIMS
	Healthy life expectancy.	edX-LIMS
Health	Sense of having enough energy to get things done.	Glimpse, TAP, ANALYSE, ILDE, edX-LIMS
	Sense that one's state of health is good.	ANALYSE, edX-LIMS
	Number of persons who have seen a health professional during a year.	Glimpse, ANALYSE, edX-LIMS
	Satisfaction with beauty or physical setting.	edX-LIMS
	Proportion of population living in households with access to basic services.	edX-LIMS
	Satisfaction with availability of good affordable housing	edX-LIMS
	Secure access to food	edX-LIMS
	Satisfaction with transportation system in the city or area one lives	edX-LIMS
Human settlements	Proportion of youth and adults with information and communications Technology (ICT) skills, by type of skill.	Glimpse, MWDEx, TAP, ANALYSE, ILDE, edX-LIMS
	Proportion of population covered by a mobile network, by technology.	TAP, ANALYSE, TATM, ILDE, edX-LIMS
	Access to internet at home.	ANALYSE, ILDE, edX-LIMS
	Having a computer at home.	ANALYSE, TATM, ILDE, edX-LIMS
	Having a cellular phone.	ANALYSE, ILDE, edX-LIMS
	Satisfaction with job.	DB, AdESMuS, Glimpse, MWDEx, TAP, ANALYSE, ILDE, edX-LIMS
	Sense that current work life is interesting.	DB, Glimpse, TAP, ILDE, edX-LIMS
	Sense that one's supervisor has respect for and cares about one's welfare.	Glimpse, TAP, ILDE
	Sense that one gets support and help from co-workers.	TAP, ILDE, edX-LIMS
	Sense that the conditions of one's job allows one to be about as productive as one could be.	AdESMuS, MWDEx, TAP, ILDE, edX-LIMS
	Satisfaction with the balance between the time spent on the job and the time spent on other aspects of life.	DB, TAP, ILDE, edX-LIMS
Work	Satisfaction with opportunities for professional development and promotion in one's current primary job.	TAP, ANALYSE, ILDE, edX-LIMS
	Sense of independence one has in performing tasks at work.	Glimpse, MWDEx, TAP, ILDE, edX-LIMS
	Average hours of training per year per employee.	TAP, edX-LIMS
	Identifying and managing economic, environmental, and social impacts.	ANALYSE
	Satisfaction with salary and benefits in current primary job	edX-LIMS
	Percentage of employees receiving regular performance and career development reviews	edX-LIMS
	Operations with local community engagement, impact. assessments, and development programs.	ANALYSE
	Mechanisms for advice and concerns about ethics.	Glimpse, TAP, ANALYSE

Table 4: Indicators selected by LA researchers to reflect the wellbeing impact of their tools

Among the 134 indicators that had been presented to the participants, a total of 61 indicators were selected to reflect the impact of the studied tools on the twelve domains of wellbeing (Table 4). Seven out of

ten LA researchers who participated in the IEEE P7010 internal analysis activity found the process useful in increasing their awareness of wellbeing domains and indicators that can be relevant to the use of their products. Six of the participants indicated that it helped them identify wellbeing impacts of their tools. Five participants indicated that it increased their capacity to address and evaluate the identified impact, and only four participants responded with yes to whether the activity allowed them to identify unintended and unexpected issues, such as potential biases and negative impacts, including how risks to human wellbeing can be mitigated (see Figure 1).

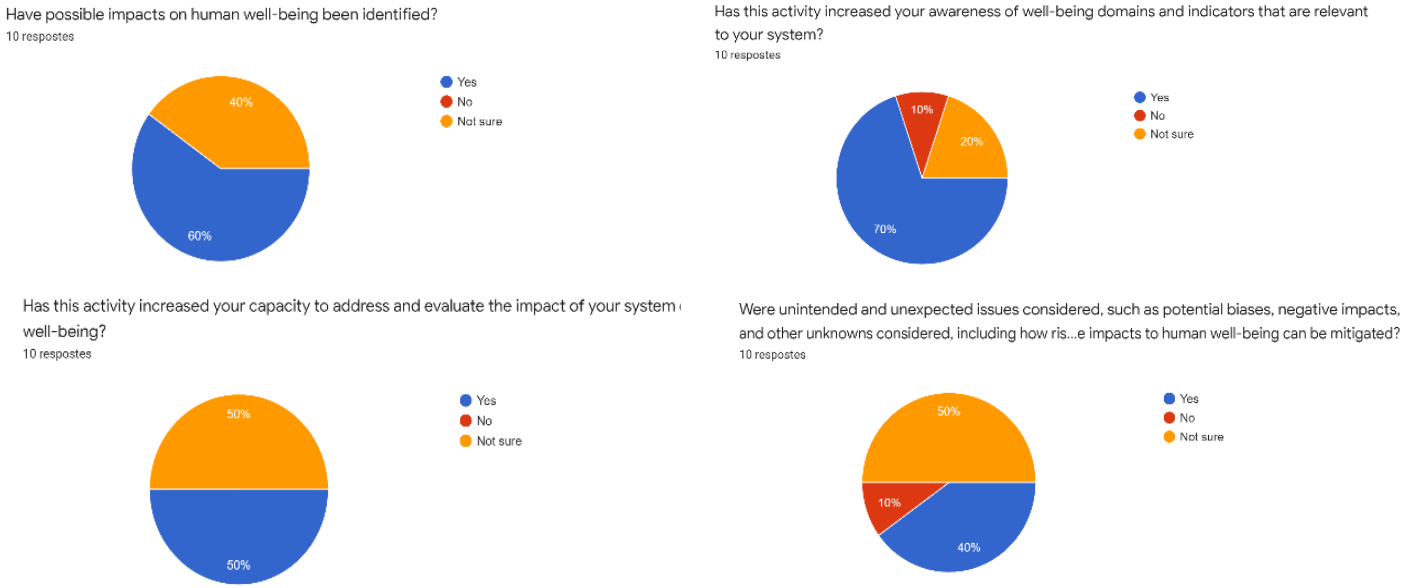

Figure 1: LA researchers' responses to the post activity survey

5. STUDY 2: Teachers' Views about the Impact of Learning Design Community platforms on Wellbeing: The case of ILDE

Learning design is defined as "the creative and deliberate act of devising new practices, plans of activity, resources and tools aimed at achieving particular educational aims in a given context" (Mor, Craft & Hernández-Leo, 2013). Learning design community platforms are web-based platforms with integrated lesson planning tools that support teachers in the creation, co-creation, and sharing of designs of learning activities.

This study aims at investigating the wellbeing impact of ILDE (Integrated Learning Design Environment), a learning design community platform, from the perspective of teachers as the intended users of such tools (Hernández-Leo et al., 2018). The invitation to participate in this study was spread among teachers of all levels in Saudi Arabia. We arranged a one-hour online session, where 78 teachers attended and were presented to a demo of the online learning design community ILDE, explaining all its uses and features. Although the tool we demonstrated was a prototype with usability challenges, the participants were able to reflect on it based on not only the extended details provided in the demo, but also on their experience with similar tools and services provided by their educational systems to support them in the novel virtual learning and teaching environments.

5.1. Data collection and analysis

Among the 78 who attended the session, 68 teachers (56 females and 12 males) confirmed the consent to

participate in the study and completed a questionnaire of 37 Likert items where they were asked to agree or disagree with statements drawn from the wellbeing indicators selected in study 1 in this paper. About 37% of the participants (25 out of 68) were high school teachers, 35% were primary school teachers, 18% were middle school teachers, and only 7 of the participants (10%) were university instructors. About 66% of the participants have been teaching for more than 15 years, while 16% and 15% of them have been teaching for 11–- 15 years and 6–- 10 years, respectively. Only two of them (3%) have less than five years of teaching experience. The responses to the survey started to arrive 25 minutes after the end of the session and the last response received was about four days later. The video tutorial of the tool had been uploaded to be available for rewatching by the participants after the session ended.

The survey items include statements that tackle both positive and negative wellbeing impacts based on the indicators that were selected by ILDE creators and shown in Study 1 (Table 4). In the case of assuming both types of impact may occur in different ways and for independent reasons, we formulate two items from the same indicator. For example, from the psychological wellbeing indicator "Feeling that the things one does are worthwhile" we developed the Likert items: "The use of the tool can make me feel that the things I do are worthwhile" and "The use of the tool can make me feel that the things I do are worthless". The format of each five-level item was as follows: 1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree, 5. Strongly agree. (Hakami and Hernández-Leo, 2021c).

5.2. Findings

In (Table 5), the positive impact is the percentage of the average number of agreements with positive statements and disagreements with negative statements within a specific wellbeing domain, while the negative impact is represented by the percentage of the average number of disagreements with positive statements and agreements with negative ones.

Wellbeing domain	Positive impact	Negative impact
Life satisfaction	70.55%	13.63%
Affect	65.94%	15.85%
Psychological wellbeing	78.68%	11.4%
Community	59.05%	18.13%
Culture	72.1%	11.8%
Economy	70.55%	14%
Environment	63.2%	11.8%
Government	63.64%	10.61%
Health	71.35%	13.2%
Education	82.4%	10.3%
Human Settlement	83.8%	7.4%
Work	70%	14.42%

Table 5: Summary of teachers' views about the impact ILDE on each wellbeing domain (n=68)

6. STUDY 3: Wellbeing and Learning Analytics Workshop: Co-designing LA to detect, quantify and measure wellbeing related aspects

To further understand how wellbeing measurement can be done through LA tools, a workshop with LA experts was carried out in the context of wellbeing in education at the Learning Analytics Summer Institute Spain (LASI Spain 2021), organized by SNOLA. The main activity of the workshop was the co-design of a LA tool from a wellbeing standpoint, a tool that could further dive into wellbeing detection

and measurement features. The objective of the workshop resided in identifying which aspects of the resulting data could help in taking one more step towards quantifying the measurement of wellbeing aspects through Learning Analytics.

6.1. Co-Design workshop format

The content of the activity was designed following the data previously collected through the internal analysis process conducted in Study 1 with LA experts. As previously exposed, the questionnaire focused on the LA tools experts usually employ and the wellbeing indicators they found most relevant and impactful in their practice. The activity was mainly built on these two elements, and it consisted of five main segments which are introduced in more detail in the next paragraph. The workshop was conducted through a hybrid setting, using the collaborative Miro platform (visual collaboration platform) as the hosting space for the activity and adapting it to participation needs since there were both online and face to face participants. Furthermore, all the collected data from the participants during the activity were automatically stored in the online platform for its posterior consultation and analysis.

The segments of the activity were five, after a brief welcome and quick agenda review; (i) *Introduction to Wellbeing and LA tools*: The first segment presented the working materials of the activity, which were the Wellbeing indicators and the LA tools previously compiled through the initial questionnaire with experts; (ii) *Icebreaker*: Since the participating profiles were various, ranging from LA experts and practitioners to doctoral students, the ideal group setting was to have a balance in both expertise and profiles. The participants were asked to choose one or two options presented in the activity regarding their level of expertise and wellbeing area of interest. Once the participants chose their options, the workshop facilitator proceeded to create the groups and balance them in regards to expertise in the LA field and common interests of the participants; (iii) *Wellbeing indicator and LA tool*: Once the groups were formed, the next step was to discuss in group and to choose which LA tool and wellbeing indicator they wanted to work with during the co-design activity (all groups were presented with the same board of information on the Wellbeing indicators and the LA tools they can choose from); (iv) *Brainstorm and co-design the wellbeing-related LA tool*: The fourth and main segment of the collaborative workshop activity. The structure of this segment was inspired by some features of a co-designing format previously used in the design of LA tools (Prieto Alvarez, Martínez-Maldonado & Anderson, 2018) and the Learning Analytics Design Cards (LA-DECK), a card-based technique that can be used to support the co-designing process of LA tools (Prieto Alvarez, Martínez-Maldonado & Buckingham Shum, 2020). This worksho''s own co-designing activity format employs a total of 6 cards inspired by the LA-DECK for the participants to fill. These cards are the following:

- *Objective card*: Define the goal you want to achieve related to your wellbeing indicator.
- *Data source car*d: Define the source of the data that should be collected in relation to both your goal and wellbeing indicator.
- *Analytics car*d: Define the analytics or set of analytics you believe are most suited to analyse your selected wellbeing indicator.
- *Metrics car*d: Define the metrics you believe are most appropriate to measure your selected wellbeing indicator.
- *Resources car*d: Define any kind of key resources you think will be necessary to achieve your goal.
- *Free space car*d: Add any other relevant info you believe is necessary to achieve your goal.

Participants were invited to add their thoughts in a sticky note inside the online board, using one sticky note per thought or idea; (v) *Evaluate your results*: In the fifth and final segment of the activity, participants were told to evaluate their results based on the ideas they came up with and the group discussion they had during the process. In order to guide this segment, 4 questions were asked:

- What are the perks of your design?
- What are the downsides of your design?
- What was the most challenging part about the co-design of your ideal tool in relation to the wellbeing indicator you selected?

- How achievable do you think your tool is? (1-5 Likert scale, 1 being *Not achievable* and 5 being *Perfectly achievable*). Justify the score accordingly.

Once the five segments of the activity have been finished, the participants are redirected to a final space where they are thanked for their active participation and are encouraged to give any feedback regarding the activity planning plus their thoughts on using collaboration tools like Miro for the co-design process.

	Wellbeing indicator	**Tool**
Group 1	Positive feelings	ANALIZE
Group 2	Positive feelings	TAP

Table 6: Third study participation summary.

6.2. Findings

The total number of participants was 18 (face-to-face and online), with 10 face-to-face participants that volunteered to actively participate in the workshop activity. The profiles were mainly two (6 LA experts and 4 PhD students). Participants were split into 2 groups of 5. To balance out the groups, each one of the two groups had at least one LA expert familiar with one of the LA tools, serving as group mediator.

Once the introductory activities had been completed, the groups proceeded to complete the main workshop activity. A summary of the most relevant responses can be seen in Table 7.

	Group 1	**Group 2**
Objective card	Extend ANALIZE to measure positive feelings.	Our goal is to know how to change TAP in order to improve the teacher's positive feelings
Data source card	Direct student feedback when working on / completing an exercise “"how do you feel about this exercise"") Video cameras EGG signals, brain signals, pulse signals Learning experience Logs with exercises Logs with videos Eye tracking Text messages Task duration Video transcription	Use of the tool while the teacher creates a plan Teacher profile Student / class profile (i) Teacher planning, (ii) Teacher expectation, (iii) Student’s results
Analytics card	Natural language processing Analyzing timestamps Process mining Pattern sequence Prediction techniques Deep learning	Tool timestamps Current state of tasks Teacher’s performance
Metrics card	Task duration Positive text Sentiment Low pulse How close to the deadline was the task completed Facial expression Consecutive positive actions Performance Efficiency	Teachers current state vs. teacher state in a previous timestamp Learning Action before vs. learning action after
Resources card	A lot of hardware (video cameras, various sensors) Integration experts	Sentiment Analysis Indicator AI model We need four

	Software implementation of the new measures Someone to do video transcripts Time and money Data analysis experts Ethical experts Pedagogical experts	employees: two developers, one AI expert, one person with educational background
Free space card	Theory on how best to measure positive feelings Usability Stakeholders implication Evaluation Validation	Direct enhancement of teacher'' feelings through student'' feelings

Table 7: Co-design workshop results: *Brainstorm and co-design the wellbeing-related LA tool* (Study 3).

Finally, the last activity was conducted as a self-evaluation of the groups' obtained results during the ideation and co-design session (Table 8).

	Group 1	**Group 2**
Positive aspects	Using hardware sensors: - Strong measure - Lots of data to analyse Using NLP and direct student feedback: - Non-invasive - "Easy" to implement	Focus on positivity
Negative aspects	Using hardware sensors: - Intrusive - Difficult in a MOOC environment Using NLP and direct student feedback: - Not the most precise measure Implementation of an algorithm to analyse all the data	Lack of meaningful data
Challenges faced	Fighting with the MIRO platform Measuring wellbeing is hard	How do we find out the correlation between teacher/student actions and positive feelings?
Is it achievable? (1-5 scale)	Using hardware sensors: - Score: **1/5** - In principle feasible to implement but requires a lot of resources and would very likely be too cumbersome for practical use. In particular if we consider that ANALYZE is used in a MOOC-context, where using hardware sensors is unrealistic (except for maybe video footage that they would have to provide voluntarily). Using NLP and direct student feedback: - Score: **5/5** - This approach seems to be more feasible as it uses student feedback and no sensors are needed. However, it is not as precise.	Viable, but a big amount of work required. Score: **3/5**

Table 8: Co-design workshop results: *Evaluate your results* (Study 3)

7. Discussion

The aim of LA research and practice to understand and improve learning and the environment in which it occurs can be extended to support other various elements of human wellbeing. The current or future integration of LA into learning technologies can be optimized to not only understand learning and improve productivity (e.g., by tracking students' performance), but also to capture and analyse relevant data that can help identify where and how these technologies impact the wellbeing of all related stakeholders. To further investigate how learning technologies could impact wellbeing considering the promising and concerning roles of LA, we used wellbeing metrics from the IEEE P7010 recommended practice to allow the digital wellbeing of selected LA-supported tools to be extensively tackled and assessed.

Despite the variety in the educational contexts, objectives, users, and stakeholders of the studied tools in this paper, possible impacts of all of them were identified on several areas within the full spectrum of wellbeing. A total of 61 Indicators (between 4 to 41 per tool) were selected by the LA experts from a list of 134 wellbeing indicators. The selections were made to reflect the potential wellbeing impact of each tool. Most of the selected indicators focused on the domains of satisfaction with one's life and job, positive and negative feelings, psychological wellbeing, community (i.e., sense of belonging), and education in both versions of formal education and lifelong learning. To a lesser extent, the domains of work and health were highlighted to be potentially impacted by several tools. Few other impacts were identified on the wellbeing domains of culture, economy (i.e., jobs), environment, human settlement (i.e., ICT) and government (i.e., sense of democracy).

The participants reported that reading about all these domains and indicators helped them become conscious about many aspects of wellbeing. However, while carrying out the analysis and the indicator selection process, many of those indicators had appeared to them as very far away from their tool context due to the nature of the IEEE P7010 standard that covers a wide spectrum of wellbeing indicators that might be relevant to a wide range of data-driven technologies. For example, the domain of human settlement included 19 indicators used to measure wellbeing on dimensions of housing, food, transportation, and ICT. Only the five indicators under the subdomain of ICT were found relevant to the participants' cases. Non-selected items also included 15 indicators that measure environmental wellbeing in dimensions of water, air, soil, and biodiversity; while the only two selected indicators in this domain were related to the satisfaction with the efforts to preserve the environment, and the knowledge about climate change.

The users' engagement in this investigation was limited to the case of ILDE learning design community platform that is mainly used by teachers. The views of 68 teachers that participated in this study about the impact of ILDE were well aligned with the hypotheses put by the system's creators regarding impacts on different dimensions of teacher wellbeing. However, they do not align with the hypotheses of potentially negative impacts, neither the ones suggested by the system's creators, nor the ones added by us to balance the survey. A possible reason for this could be the differences in the levels of criticism and awareness of harm between the system's creators (i.e., researchers), and the users (i.e., teachers). In the stage preceding this study, the researchers had attempted to adhere to the IEEE P7010 internal analysis regarding the rigor of their assessment of the well-being impacts, by assuming several scenarios of varying likelihood of occurrence, some of which are found unlikely by the users. For example, the researchers expressed that the negative feelings of anxiety and frustration could be resulting from the feeling of being monitored, the need to contribute to the collaborative community, and the feeling of not being creative enough when exploring peers' work, while most of the teachers in this study do not report such possibilities.

As a means to obtain more specific results on what are the most relevant wellbeing aspects for educational stakeholders, in the third study we worked with a reduced list of 6 wellbeing indicators (satisfaction with life, positive feelings, negative feelings, sense of one's work worthiness, sense of capability, sense of leading a meaningful life and sense of belonging to a community) and 5 LA tools (Dashboard Generator, ANALYSE, AdESMuS,

Glimpse and TAP), all previously compiled in the first study with LA experts. The criteria for selecting these tools consisted in (i)participants having sufficient knowledge of the tools and (ii) interest shown in the specific wellbeing indicators exposed above.

In this third study there were 2 groups that volunteered to actively participate. Each group worked with a different LA tool (TAP and ANALYSE) and the same wellbeing indicator (positive feelings). Since they had the freedom to choose these two factors and both coincidentally chose the same wellbeing indicator, it was a good opportunity to compile data and compare it from two different yet similar LA tools' perspectives.

We were able to obtain relevant data on what are the critical analytics and metrics we should be looking at to better assess and potentially measure wellbeing, yet the connection and correlation of the data obtained from the LA tool with the specific wellbeing indicator still seemed unclear, a challenge both groups exposed in the evaluation of their co-designed tool. Group 1 went a step further and brought ethics onto the table by stating that even though measuring wellbeing might be a hard feat, there are some technologies that could be used, i.e., hardware sensors, but their risk was high due to their intrusive nature. They came forth with a second scenario where the measurement of wellbeing could be done by using NLP and direct student feedback, but the precision factor gets greatly affected, unlike the first scenario with hardware sensors. However, they exposed this second scenario as more achievable at least in the short run.

Another element of high importance brought forth by Group 2 is theory on how to measure positive feelings, which leads us to an even more complex challenge: how do we automate the measurement of positive feelings (and wellbeing for that matter) through LA tools without compromising neither the precision of the results nor the ethical aspects of teachers and students?

It is important to indicate that the IEEE P7010 WIA approach does not tackle neither the harms that can be induced by the misuse of data, nor the data agency principles such as privacy and fairness. Hence, the process of data collection and management for the use of IEEE P7010 recommended practice can itself have negative impacts on wellbeing. Therefore, other codes and guidelines (e.g., data protection regulations such as GDPR in Europe, IEEE P7003TM Standard for Algorithmic Bias Considerations) must be followed in conjunction with the application of this standard to address ethical considerations related to data agency.

7.1. Future Work

The continuation of this work for each tool includes collecting objective data through more user engagement, identifying data sources to detect wellbeing issues beyond positive feelings, and creating a wellbeing dashboard. This dashboard should be designed in a fashion where data over time is integrated to provide useful, timely and relevant wellbeing information based on the indicators selected in the earlier phases. Such for monitoring, management, and improvement of the tool to help safeguard wellbeing.

Yet, this approach can be restricted by practical challenges and faced by philosophical arguments that find it difficult to avoid negative impacts through better design of technology and urge to direct these efforts toward training users on healthy and positive use of technology. On a practical level, identifying data sources and analytical techniques for questions such as: how to measure students' and teachers' satisfaction, stress, capability, and belonging in LA-supported learning environments is an area that requires further research.

Agradecimientos

This work has been partially funded by the Ministry of Science and Innovation and the National Research Agency of the Spanish Ministry of Science and Innovation (PID2020-112584RB-C33/MICIN/AEI/10.13039/501100011033, PID2020-112584RB-C32, PID2020-112584RB-C31, RED2018-102725-T). D. Hernández-Leo (Serra Húnter) acknowledges the support by ICREA under the ICREA Academia program. P. Santos acknowledges the support by the Spanish Ministry of Science and Innovation under the Ramon y Cajal programme. E. Hakami acknowledges the grant by Jazan University, Saudi Arabia.

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