Inclusive Peer Learning with Augmented Reality Apps

IO2 Compendium of iPEAR research & cases

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Erasmus+

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Executive summary

The inclusive Peer Learning with Augmented Reality Tools (iPEAR) project is a three-year Erasmus+ project KA203 - Strategic Partnerships for higher education- with a mission to streamline the adoption of innovative, collaborative, and empowering pedagogies, tools, and assessments. The project combines the collective expertise of technology-enhanced learning researchers, computer scientists, and educators to build a strategic partnership.

Peer learning frames the new capital of the infosphere (Themelis, 2022). Social media usually takes advantage of our online friends to sell goods and services (the power of an online user is the number of followers). On the positive note, students and educators find 'learning friends' as co-travellers to help them acquire new skills or digest information as creative work with others that provide micro-scaffolding in class and online. The Peer-to-Peer instruction model, originated by Aric Mazur in 1997, offers significant evidence that it could make learning more efficient, collaborative, and empowering for students.

Educators and students must develop creative visual content as a new form of reading, writing, and disseminating information and identities. Visuals are the new language to be explored and efficiently used. AR is a rapidly growing market amongst ICT technologies as a form of visual literacies in many fields, such as education, marketing, and medical training. AR provides an enriched view of the physical world, adding layers with contextually helpful information delivered visually or by stimulating other senses using hand-held or wearable devices.

The project targets higher education (educators and their students) research and maps the educational use of AR, focusing on collaborative and peer learning approaches. It intends to facilitate the adoption of AR in education by creating open-access teaching and learning material for educators. It also aims to develop and maintain a community of experts in educational AR and other stakeholders to ensure the project's sustainability and keep the most valuable results up-to-date.

Table of Contents

Development of the document

Revi-sion	Date	Author (s)	Status	Description
1	31/10/2022	Chryssa Themelis	Draft	First draft version
2	31/01/2023	Chryssa Themelis	Draft	Second complete draft, reviewed by partners
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Table of Abbreviations

Acronym	Full name
iPEAR	Inclusive Peer Learning with Augmented Reality Apps
AR	Augmented Reality
EUCEN	European university continuing education network
FAU	Friedrich-Alexander-Universität Erlangen-Nürnberg
NTNU	Norges Teknisk-Naturvitenskapelige Universitet
IHU	Diethnes Panepistimio Ellados
AKTO S.A.	AKTO Art and Design College
HE	Higher Education
HEIs	Higher Education Institutions
MOOC	Massive Open Online Course
P2P	Peer to Peer
IO (IO1-IO3)	Intellectual Outputs from 1 to 3
TPM (TPM1-TPM5)	Transnational project meeting from 1 to 5

Partners

Organisation	Country of organisation	Project Role
FRIEDRICH-ALEXANDER-UNIVERSITAET ER-LANGEN NUERNBERG (E10209513, DE) FAU	Germany	Applicant Organisation
NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU (E10209399, NO) NTNU	Norway	Partner Organisation
EUROPEAN UNIVERSITIES CONTINUING ED-UCATION NETWORK (E10082854, BE) EUCEN	Belgium	Partner Organisation
DIETHNES PANEPISTIMIO ELLADOS / INTERNATIONAL HELLENIC UNIVERSITY IHU (E10162117, GR) IHU	Greece	Partner Organisation
AKTO S.A. (E10162068, GR) AKTO	Greece	Partner Organisation

Introduction: Peer-to-peer (P2P) learning and AR

The iPEAR approach combines the pedagogy of peer learning with the technology of Augmented Reality, assuming that this enhances students' motivation and engagement in their learning process. Case studies have been collected during the research to prove this assumption's solidity. A literature review carried out at the beginning of this research showed no results on the iPEAR approach. The existing research either focuses on the phenomenon of peer learning or the supporting character of AR on individual learning results.

Educational research is still limited and underfunded. According to Evans et al. (2021), only 13% of the published educational research praxis follow the appropriate objectives, aims, paradigms, and methods standards. Unfortunately, no research combines both approaches, peer learning and visual literacies, in terms of augmented reality tools. That is why the Compendium will be based on the best cases of the iPEAR projects. An extensive literature on the advantages and disadvantages of the holistic pear project will be further developed in the pedagogy (IO3), embracing the philosophy, science and art of teaching. The specific document will present a brief overview of peer learning and AR potential.

Peer-to-peer (P2P) instructions originated by Eric Mazur in 1997 when he published research on the P2P perspective and hard evidence based on Harvard students in physics courses. Professor Mazur proved that students are more motivated and engaged when they learn with their classmates and consequently learn better. Moreover, their perception of the course positively changes and enhances awareness about learning outcomes.

Another study (Zhang, Ding, and Mazur, 2017) analysed pre-post matched gains in the epistemological views of science students taking the introductory physics course at Beijing Normal University (BNU) in China. In this study, they investigated the attitudes and beliefs of science majors (n=441) in four classes, one taught using traditional (lecture) teaching methods, and the other three taught with Peer Instruction (PI). In two PI classes, student peer groups were constantly changing throughout the semester, while in the other PI class, student groups remained fixed for the semester. The results of the pre-and post-test using the Colorado Learning Attitudes about Science Survey showed that students in traditional lecture settings became significantly more novice in their beliefs about physics and learning physics over a semester, a result that was consistent with what was reported in the literature. However, all three classes taught using the PI method improved student attitudes and beliefs about physics and learning physics. Students exhibited a more remarkable positive shift in attitudes and opinions in the peer learning class with fixed peer groups than in the other PI class with changing peer groups. The study also looked at gender differences in student learning attitudes. Gender results revealed that female science majors in the PI classes achieved a more remarkable positive shift in attitudes and beliefs after instruction than male students.

In the same line of thinking, Enda Tuomey's thesis (2014) on Peer feedback on writing essays in an online forum for learners of English examined feedback, interaction, and knowledge creation in an asynchronous discussion forum. Learners of English provided peer feedback on short argument essays for the IELTS test, a gatekeeper English exam used for immigration or university entrance. The author claims that peer feedback was viewed as a process with benefits for both givers and receivers in the case study rather than as a product given by an expert.

Regarding visual media, Bobby Murphy, the co-founder of Snap, says: "Augmented-reality glasses will become the norm within a decade" (MIT Technology Review). AR tools have been serving marketing and business well as a creativity portal. It is time that education explores the potential of visual media to enhance life-long learning.

According to Sir Ken Robinson, creativity is as important as literacy in education. AR, as part of visual literacy from technology-enhanced learning (TEL) perspective, has the potential to improve the teaching repertoire. Moreover, it could create new behavioural patterns for learning, such as visual thinking, reading and writing. Professor Sousanis, who wrote the first PhD thesis in comics form (Unflattening, 2015) notes that the art of visual teaching describes the nonlinear, tangential ways our thinking moves. AR could embrace the benefits of visual learning.

Dozens of studies have proven similar results. A more thorough analysis of the benefits of P2P and AR separately is found in the intellectual output O3: pedagogy for iPEAR.

1. Research design

1.1 Methodology & philosophical background: informed grounded theory

Grounded Theory (GT) is finding and analysing data concerning theory and praxis. The Grounded Theory methodology was developed by Glaser and Strauss in 1967 to describe the qualitative research method they used in their sociological research Awareness of Dying in 1965. They adopted an investigative research method with no preconceived hypothesis and used comparative Analysis to formulate a theory grounded in the data. Therefore, they named the methodology "grounded theory" (Glaser & Strauss, 1967). Over time, many definitions, revised versions, and conflicting perspectives emerged. Mjøset (2005, p. 379) defines it as "a case of the explanation-based type of theory reflecting a pragmatist attitude". Creswell (2009, p.13) frames grounded theory as: "a qualitative strategy of inquiry in which the researcher derives a general, abstract theory of process, action, or interaction grounded in the views of participants in a study". While a variety of definitions for GT have been suggested, the study uses the illustration of Thornberg and Charmaz (2000;2006;2012), who saw GT as a systematic yet flexible method that emphasises data analysis, involves simultaneous data collection and analysis, uses comparative methods, and provides tools for mapping territories and formulating pedagogy. Additionally, Thornberg (2012; Charmaz& Thornberg,2012) named it Informed Grounded Theory because it is informed by existing literature and theories and constantly refreshed with updates in research (Themelis, Sime and Thornberg, 2022).

1.2 Epistemology & ontology of iPEAR research

Philosophically, ontology entails people making claims about what knowledge is, epistemology is how people know it, axiology is what values go into it, rhetoric is how people write about it, and methodology is studying it (Creswell, 2003, p.6). "To ensure a strong research design, researchers must choose a research paradigm congruent with their beliefs about the nature of reality. Consciously subjecting such beliefs to an ontological interrogation in the first instance will illuminate the epistemological and methodological possibilities that are available" (Mills et al., 2006b, p.26). According to Crotty (1998, p.3), epistemology is "the theory of knowledge embedded in the theoretical perspective and thereby in the methodology". A constructivist grounded theory (CGT) recognises that data do not open a window to reality; instead, the 'discovered' subjective truths arise from the interaction with its temporal, cultural, and structural contexts (Charmaz, 2000). Thus, the researcher takes a snapshot of what is going on at a specific time, in a particular place, from the gaze of specific viewers. Like an eagle flying above, she compares what she sees with other perspectives to create a mosaic of concepts that can be conditionally related to purposes or grouped to form generic concept categories. The findings of this study are either the construct of participants and analysts' perceptions (Charmaz, 2006) or data emerging during the investigation process (Glaser, 2005). Both concepts are not mutually exclusive in my mind as a researcher, but they can provide a more holistic explanation of phenomena.

Furthermore, causality is suggestive because it remains open to refinement, and outcomes are not seen as accurate but as helpful or not. In other words, CGT analysts try to "interpret how subjects construct their realities" (Charmaz, 2000). "Ontologically relativist and epistemologically subjectivist, constructivist grounded theory reshapes the interaction between researcher and participants in the research process and in doing so, brings to the fore the notion of the researcher as author" (Mills et al., 2006b, p.31). To top it all, art and science harmoniously coexist in the process of reconstructing the subjective realities of the participants

(Strauss & Corbin, 1998). In the context of iPEAR, the participants' stories are filtered by the researcher's skilfulness and the interview process's social interaction, meaning that subjective interpretations are socially constructed or data emerging to form a perception of a specific phenomenon (iPEAR forms and possibilities). Art as creativity or inspiration, and science as a meticulous research process and literature review, work hand in hand to formulate a pedagogy while explaining iPEAR praxis.

1.3 Axiology: criteria for evaluating the iPEAR research findings

Research should be evaluated by the constructs used to generate it (axiology).

1.3.1 External validity versus Transferability/Practicality

One constraint of this study is the nature of grounded theory research regarding the concept of generalizability or external validity. Grounded theory is appropriate for 'theory building', but it is not suitable for "theory testing" (Woolley, Butler & Wampler, 2000, p. 318). The inability to generalise to larger populations is the primary limitation of grounded theory (Gall, Gall & Borg, 2003). "All research is interpretive; it is guided by the researcher's beliefs and feelings about the world and how it should be understood and studied. Some beliefs may be taken for granted, invisible, only assumed, whereas others are highly problematic and controversial" (Denzin & Lincoln, 2005, p.22). Thus, constructivist grounded theory must esteem every human as unique and value all views even when contradictory. A specific instructional design may be effective for a group but cannot be considered 'best practice' for another. Therefore, the term generalizability is deemed inappropriate epistemologically for the iPEAR study, and it is not the primary goal of grounded theory. However, educators, policymakers, and instructional designers could make informed decisions based on the research findings.

It would be a realistic goal of grounded theory to use the term practicality or transferability (Anfara, Brown & Mangione, 2002), pointing to the fact that theories constructed are a part of a never-ending research refinement, facilitating future research. In other words, research findings aim to explain some educational forms and possibilities of iPEAR and the corresponding contextual factors. Hence, educators decide what may be practical for them to implement at different times with different student groups. By providing a pedagogy of the form and potentials of iPEAR from tutors' perspectives. However, transferability has nothing to do with the notion of "best practice" that can fit all models, and it is more like a 'collage' of concepts that the researcher could examine in the future. Educators may adapt their unique teaching methods or learning objectives for specific learners in specific circumstances. The practicality of GT concerns itself with social good and usefulness, and therefore, it should be practically helpful for professionals and laypersons (Selden, 2005; Glaser & Strauss, 1967). Both concepts of practicality and transferability aim at describing better research purposes.

1.3.2 Reliability versus Internal Validity

A constructivist contextual perspective holds that human behaviours and the roles of the researcher are dynamic and, therefore, cannot be replicated by other academics. Thus, the concept of reliability in terms of replication is tied to quantitative and positivist reasoning and is out of the frame of the iPEAR study. The question remains: "How can an inquirer persuade his or her audiences that the research findings of an inquiry are worth paying attention to?" (Lincoln & Guba, 1985, p.290). The concept of internal validity conceptualised as "dependability" or "consistency", which can be a realistic goal of grounded theory (Anfara et al., 2002, p. 29), is in agreement with the iPEAR epistemology and ontology. Consequently, to establish internal validity, this study utilised the following procedures: member checking (Lincoln & Guba, 1985), researcher reflexivity and transparency (Charmaz, 2006), rich and thick descriptions (Creswell & Miller, 2000), and thorough literature review that bases on categories of the analysis and contextual factors. Charmaz (2006, p. 132) agrees with Glaser that grounded theory is not a verification method and offers the term "plausible accounts" in contrast to *verified knowledge.*

Axiology is the set of criteria to which the Analysis (Thematic Analysis) is accountable. Lorelli S. Nowell (2017) defined some trustworthiness criteria interwoven thematic Analysis. Axiology is the set of standards according to which the process and research findings could be evaluated.
Credibility - Guba and Lincoln (1989) claimed that the credibility of a study is determined when co-researchers or readers are confronted with the experience; they can recognise it.
Transferability refers to the generalizability of the inquiry. Qualitative research concerns only case-to-case transfer (Tobin & Begley, 2004).
Dependability - researchers can ensure the research process is logical, traceable, and clearly documented.
Confirmability deals with establishing that the researcher's interpretations and findings are clearly derived from the data, requiring the researcher to demonstrate how conclusions and interpretations have been reached (Tobin & Begley, 2004). According to Guba and Lincoln (1989), confirmability is established when credibility, transferability, and dependability are achieved.
Audit Trails - an audit trail provides readers with evidence of the decisions and choices made by the researcher regarding theoretical and methodological issues throughout the study, which requires a clear rationale for such decisions (Koch, 1994). Sandelowski (1986) stated that research and its findings are auditable when another researcher can clearly follow the decision trail.
Reflexivity embraces the need to keep a self-critical account of the research process, including their internal and external dialogue (Tobin & Begley, 2004). A reflexive journal can be used by researchers to record the daily logistics of the research, methodological decisions, and rationales and to record the researcher's personal reflections on their values, interests, and insights information about self (the human instrument; Lincoln & Guba, 1985).

1.4 Mixed methods

The overarching research question is: Will the iPEAR approach improve students' motivation, engagement and autonomy? How?

1.4.1 Quantitative data - Students' survey

Sampling: Twenty-one higher education educators from Greece, Germany and Norway were interviewed, while 214 students responded to online surveys. The respondents, undergraduate students from various national backgrounds, come from a broad spectrum of disciplines. They are all well-informed about research procedures and ethics.

1.4.2. Qualitative data: educators' interviews & thematic analysis

A thematic analysis approach was selected for this study to contribute to qualitative interpretative research. The three main categories under investigation are students' motivation, engagement, and empowerment (responsibility for learning), but the researcher is open to other categories if need be. Thematic analysis is one of social science's most common qualitative data analysis techniques (Holstein & Gubrium, 1994).
Thematic analysis is a data reduction and analysis strategy by which qualitative data are segmented, categorised, summarised, and reconstructed to capture the critical concepts within the data set. Thematic Analysis is primarily a descriptive strategy that facilitates the search for patterns of experience within a qualitative data set; the product of thematic Analysis is a description of those patterns and the overarching design that unites them. Thematic coding is the strategy by which data are segmented and categorised for thematic analysis" (Ayres, 2008, p.867).
Theme identification and coding are typical characteristics of qualitative research. Some researchers utilise software programs such as NVivo to systematically group data in similar ideas, while others prefer to do it manually (Kelle, 2004; Seale, 2000). For the iPEAR project, the procedure was manual based on Welsh's (2002) criticism of computer-assisted qualitative

data analysis software compared to manual methods. Welsh (2002) argues that combining both ways would be ideal for securing a rigorous qualitative analysis but relying heavily on software might not be adequate. In the same line of thinking, Welsh (2002) argues that "the software is less useful in terms of addressing issues of validity and reliability in the thematic ideas that emerge during the data analysis process, and this is due to the fluid and creative way in which these themes emerge" (p.9).
The thematic analysis could be practical for the XR study for the following reasons: First, it enhances the researcher's opportunity to deal with diverse subjects via interpretations (Boyatzis, 1998) and to understand widely various aspects and data that have been gathered in different situations at different times during the project (Marks and Yardley 2004). Second, the flexibility of thematic analysis enables the researcher to apply both inductive and deductive methodologies (Frith and Gleeson 2004; Hayes 1997) to ensure that themes are effectively linked to the data (Patton, 1990) and can be achieved, and an in-depth analysis of participants' behaviours actions and thoughts ((Hatch 2002; Creswell 2003). Namey et al. (2008) conclude that thematic analysis "may include comparing the relative frequencies of themes or topics within a data set, looking for code co-occurrence or graphically displaying code relationships" (p.138). Finally, the thematic analysis contributes toward understanding the similarities and differences between participants' perspectives, which leads to an appreciation of the whole picture (Joffe & Yardley 2004; Blacker 2009).

1.5 Ethics

Each institution is responsible for the ethical procedures (ethics committee, consent forms, storage of data, anonymity of the research informants) within the educational institution in each country.

1.6 Students Survey - Analysis

The hypothesis testing statistics aims to answer the question: Is the iPEAR pedagogical approach practical according to students' perspectives? The sub-questions are: Is the process exciting and empowering for the students? Could it be used in many courses and disciplines? The convenience sample is undergraduate students from Germany, Norway and Greece from various fields: medicine, archaeology, graphic design, and media studies, to name a few. The survey included (214) participants in total: 16 informants from Germany, 17 from Norway, and 181 from Greece.
The students' data are considered inferential statistical data. Inferential statistics help to come to conclusions and make predictions based on your data. The statistics focus on frequency distribution and are visualised in tables per country, totals, and graphs. The analysis of the elaborated responses (open-ending questions regarding - why) is thematic regarding the effectiveness of the holistic pedagogical approach combining peer learning and AR tools, students' motivation, empowerment, and future use. The elaborated answers explain students' rationale; responses are analysed in positive and negative comments (as generic codes) because even neutral responses usually make positive or negative comments. The words were analysed into themes in the summaries and reviewed and interpreted in the conclusion section.
Research questions for the online survey for students (Likert scale 1-5 strongly agree - strongly disagree):
Question 1: Did you like the peer learning approach (working with and teaching your classmates)? (Likert scale of 1-5 strongly agree – strongly disagree) Why?

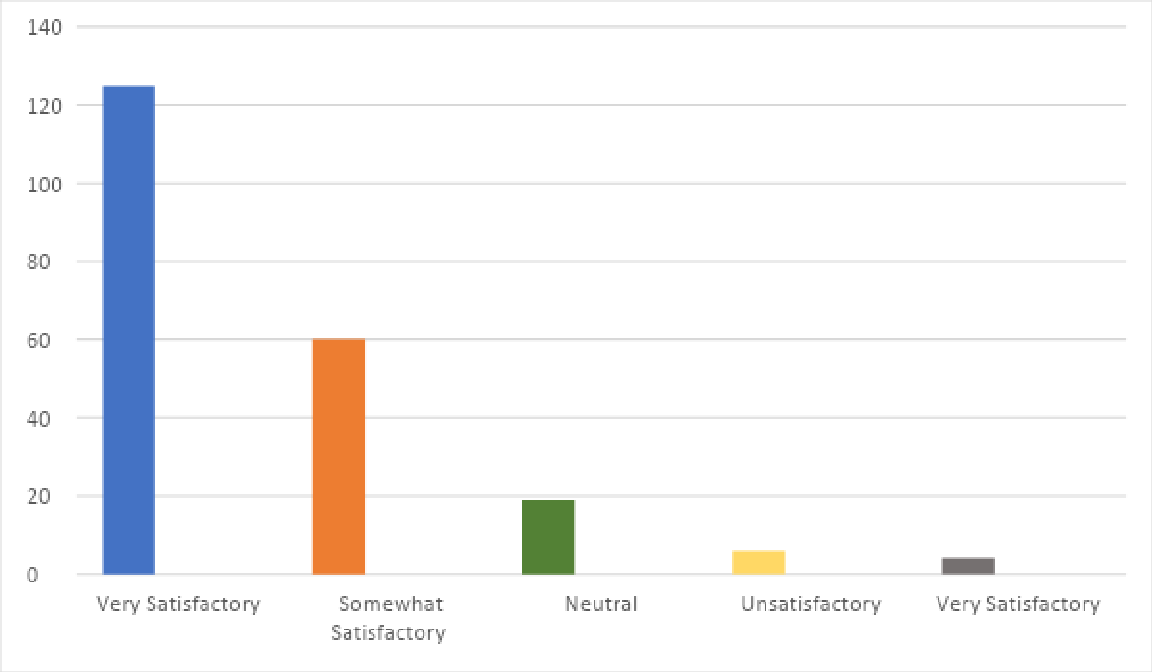

Figure 1: Number of informants in total for question 1.

The students appreciated the iPEAR perspective of learning while teaching one another (185/214), while nineteen were neutral, and ten found it unsatisfactory or very unsatisfactory. The illustrated answer to 'Why?' positively commented that the method was engaging, motivational, creative and innovative, teaching them new digital and cooperation skills. On the negative side, technical issues such as compatibility, digital divide and internet connection affected the efficiency of the iPEAR task. On the same wavelength, cognitive overload (tiredness and headaches, poor collaboration, hesitation in trying new technology and educators' preparedness) affected the learning outcome of the peer-learning with AR tools.

Question 2: Were you more interested in teaching each other and sharing content with your peers and AR tools? (Likert scale of 1-5 strongly agree – strongly disagree) Why?

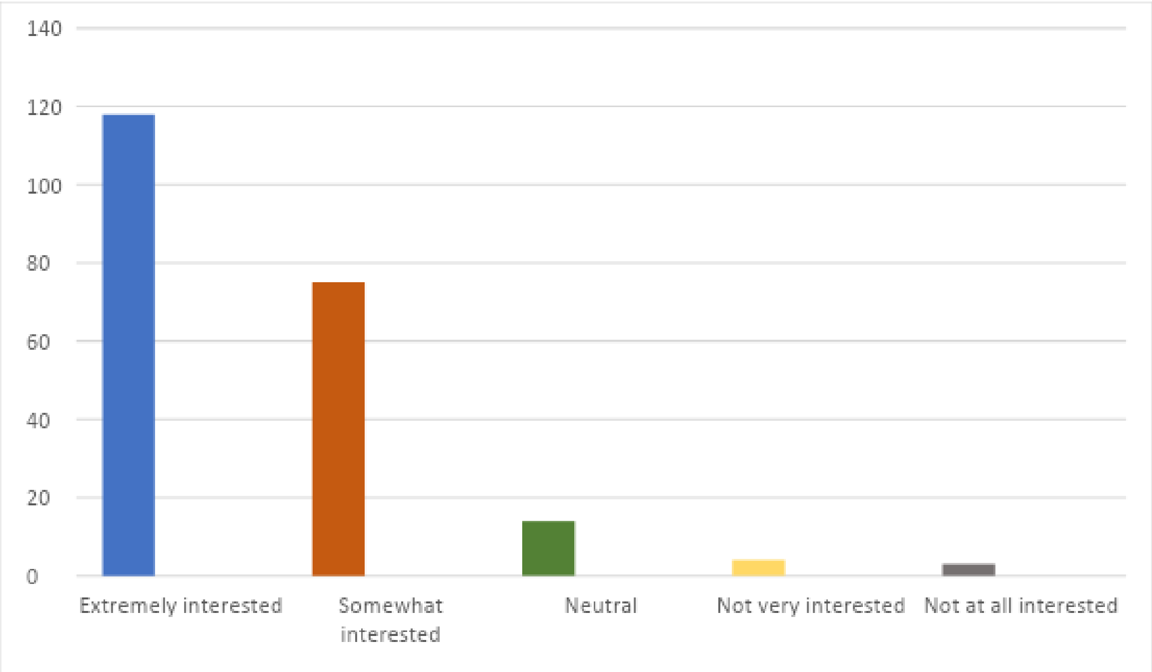

Figure 2: Responses to question 2 in total.

All in all, 183 out of 214 participants were 'interested or very interested' in the project, 17 were neutral, and 7 were uninterested.

In summary, the positive comments concentrated on the innovative use of tools for learning, the quality of collaboration in class and online, and the AR technologies' visual elements. The iPEAR task helped them learn together in a fun, game-like and creative way that triggered enthusiasm, motivation and personal responsibility for learning with peers. In some cases such as the FAU some students felt empowered to experiment with innovative platforms such as Metaverse.

The few negative comments focused on technological issues, such as technology's role in the task and the availability of devices. One student felt anxious when trying out new technologies.

Question 3: Did this learning approach make you feel more responsible for your learning? (Likert scale of 1-5 strongly agree – strongly disagree)

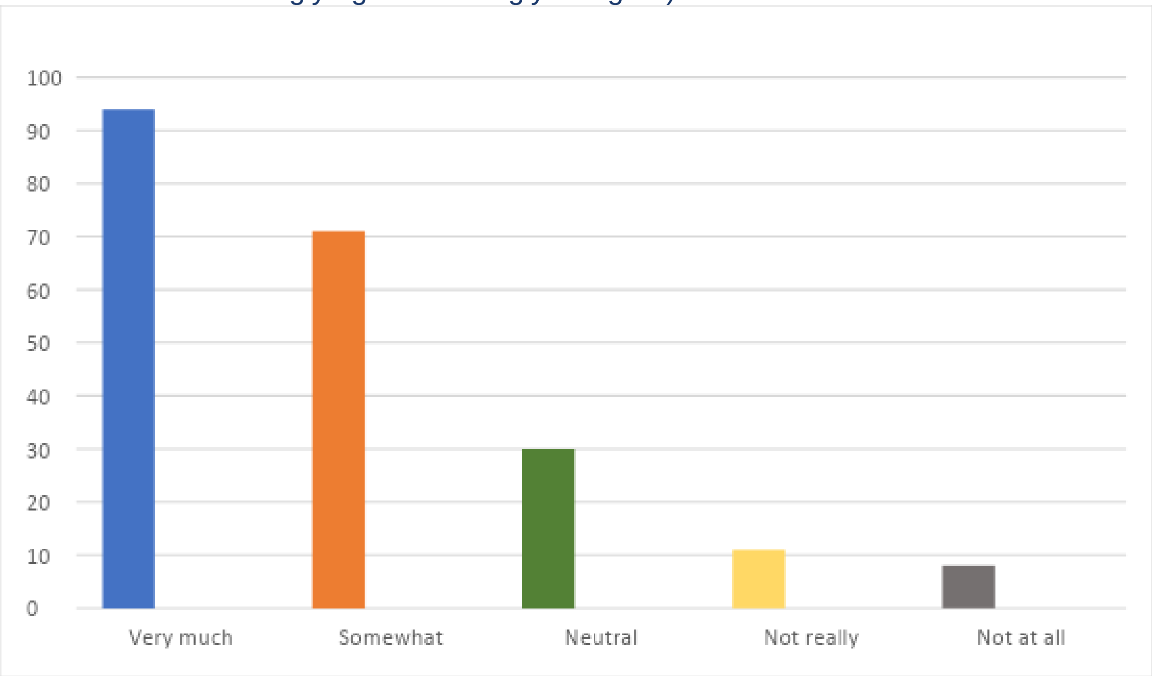

Figure 3: Students' responses to question 3 in total.

Despite the different tools and disciplines, the responses regarding empowerment were overall positive; 165 out of 214, 30 were neutral, and 19 were negative. The students who didn't feel empowered considered the iPEAR learning childish and preferred a more teacher-centred approach rather than taking the responsibility of knowledge sharing with others.

On the positive spectrum, research informants were excited that they were allowed to improvise with the tools, brainstorm with ideas and work with others. They felt responsible for the learning outcome of the iPEAR task, so even the so-called 'bad' students participated more.

Question 4: Do you think it would be helpful in other courses as well? (Likert scale of 1-5 strongly agree – strongly disagree) Why?

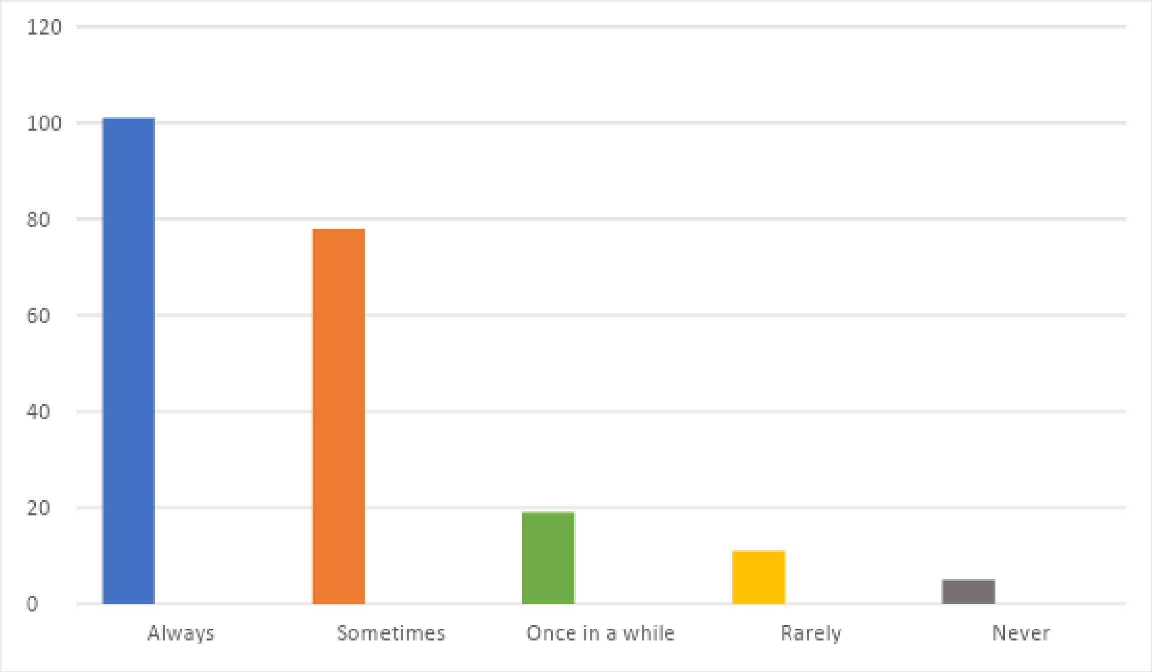

Figure 4: Students' responses to question 4 in total.

To sum up, most students (101/214) think that the iPEAR approach has the potential to always be applied in courses. 78 claim that it could be used sometimes, 19 once in a while, 11 rarely and 5 never. The negative comments focus on the misconception that AR is for children, the reluctance to work and learn with others, and the lack of incentives. The statement that visuals are tiring refers mainly to HoloLens headsets. Technologies are challenging, especially for inexperienced students; some see barriers to using iPEAR in disciplines such as maths.
On a positive note, visuals make learning more experiential and better explain abstract concepts. Digital skills are essential and social interactivity makes learning fun and more engaging.

1.6.1 Reflections on the quantitative data

The hypothesis that the iPEAR approach is a practical learning method is confirmed based on the frequency of responses-inferential statistics. As a generic pilot study that aims to map the technology-enhanced pedagogical interventions, it shows evidence that the iPEAR approach could enhance students' interest, motivation and empowerment in a broad spectrum of courses.
Despite the various tools and disciplinary boundaries, the student's perspective on the iPEAR approach was cumulatively positive. The tasks have been applied to archaeology, history, medicine, graphic, design, and photography courses, to name a few. Students used simple tools such as QR codes, mobile or web-based apps and elaborate devices such as HoloLens. They felt **engaged, motivated and empowered to work creatively with their 'leaning buddies' to explore AR, visuals and human-to-human relationships.** Brainstorming **creative ideas** was evident. They strongly recommended further **exploring the pedagogical model in different courses and disciplines**. The pedagogical model promotes **gameplay, visualisation, wonder and discovery learning** instead of boring lecture time. They could apply **AR digital skills and cooperation experience in their future career.**
The side effects of the iPEAR approach should not be ignored as well. The biggest obstacle that hinders the process is the so-called **technical divide**. Some devices, such as HoloLens, are expensive to be bought by institutions. The Bring your own device (BYOD) perspective causes difficulties due to socioeconomic status. Some students have elaborate smartphones that support AR technologies, while others may not afford to buy such devices. Compatibility

issues arise with some devices as well since there are significant differences, for instance, between apple and android devices.
Some students claimed that they needed more **training**, manuals or **better instructions from the educators** that could frame the activity concerning the learning objective of the course and the **quality of communication with their peers.**
Few participants were hesitant to use new technologies and preferred traditional teacher-centred approaches. Another issue was **tiredness or headache from using visuals for an extensive period**, as in the case of using HoloLens.

1.7 Educators' interviews - Analysis

Educators were asked to identify five elements via semi-structured interviews: to determine if the holistic iPEAR pedagogy could facilitate the course objectives, to what extent and how. Secondly, they were asked to explore students' motivation, engagement, and autonomy in working with their peers (with or without the intervention of an educator). More categories emerged from the data, including inclusion, creativity, group dynamics and visualisation. Finally, the study focused on how the iPEAR instructional design could be improved or used more effectively.

The holistic iPEAR pedagogy

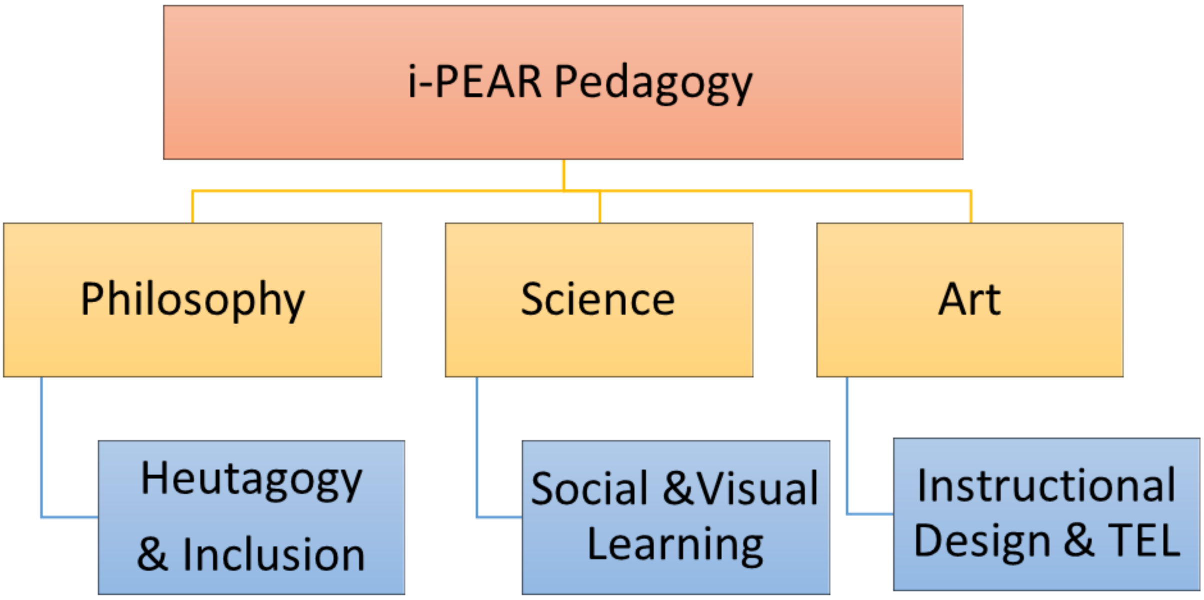

Figure 5: General categories of iPEAR pedagogy.

The iPEAR pedagogy considers three critical variables: the philosophy of Heutagogy (Self-direction and self-efficacy), inclusive praxis as democratic participation in life-long learning, social learning theories (P2P approach), visual media literacy and the artistic element of developing an instructional design that addresses the technology-enhanced learning perspective. This study focuses on exploring the potential of AR in Higher Education.
Overall, the educators' feedback on iPEAR was **positive and served the learning objectives**. There were three cases where the educators felt unsure of the learning outcomes or the technologies available but were willing to try the iPEAR approach again, understanding the potential of it. One educator claimed it did not work well because the students could not apply the instructional design to the music course. Even though the other two educators felt that the learning objective may be served partly, they noted that peer learning functioned well

as a **supportive mechanism for learning** with a powerful impact on engagement. Informants claimed that AR-selected tools provided the students with new ways of creating and interacting with the natural world and experiences that would not be possible in a completely real or virtual world. The immersive experience helped students think critically and reflect on their contribution before participating in the final conversation with their classmates and educators.

Peer learning strongly motivated students to explore AR tools by exchanging ideas about the tool's possibilities and effectiveness. While AR, as a **creativity channel, promoted explorative learning** and problem-solving, creativity was considered a form of literacy in the iPEAR experiment. An educator said: "Students as explorers are part of the same expedition. It is also essential to note that the AR apps helped students understand new creative paths." Another educator commented: "The combined AR and peer learning approach helped a lot because completing the projects that the students had in mind was achieved more directly and quickly. It also helped students create impressive images with the application, and they guided each other, making the lesson more vivid and interesting."

Therefore, the overarching question about the effectiveness of the iPEAR framework was affirmative but not without guidelines and restrictions, as we will discuss below. Peer learning as a supportive mechanism promoted learning on new paths, and AR opened a creativity portal. One educator even talked about enriching the learning outcomes with digital skills, visualisation for retention, critical assessment and creativity.

Some aspects of iPEAR **learning are unintentional** (such as empathy and solidarity) and worthy of further investigation.

Students' motivation, rewards and insecurities

Educators maintained that the iPEAR design functioned as a motivational force because of the social interaction, excitement of working with innovative tools, social responsibility for learning and visual and immediate feedback as a rewarding process. Of course, the most creative instructional design of the activity reinforces the rewards for students. Rewards could be grades, the assessment of the task by their peers (respect from peers), or the enjoyment of producing visual content with classmates and building digital skills with innovative tools such as AR.

As a German educator noted*: As soon as you do group work, you're the heroine. This shows the ambition to achieve a good result and put a lot of work into the projects. I find that intrinsic motivation is higher than in other seminars I know on this level.*

A Greek educator said: *They are satisfied through iPEAR and the three general motivational indicators: choice, effort and perseverance; the fun and responsibility of the role of the trainer undertaken by the students helps them to recognise their needs and provides opportunities for choice and control of the learning process. Thus, it helps students understand internal and external motivations to learn.*

Expectations about grades could be part of the equation as long as the criteria for evaluation and expectations are clear. Visual learning played the role of a robust motivation mechanism. In short, interpreting the subject content visually was a motivational and rewarding drive for educators and students because of the innovative learning style and technologies.

Students with low academic performance were also motivated. An educator argues that *this approach touched students who have been active in class, due to low academic performance, through social interaction and taking responsibility in learning.*

Moreover, they claimed that the students broaden their visual language boundaries through peer learning and new technologies. As an informant put it: *the students, for the first time, experienced peer learning and were motivated to participate in the learning procedure. They find it very exciting to participate.* Another one said: *The team is happy with the learning results, as they mentioned the learning experience was like a treasure hand game*.

An educator from Norway said: *It was very apparent that the students were very enthusiastic at the end; they said that this was a great way of teaching.*

Tools, technical issues & technophobia or insecurities

The tools used in the research are

- HoloLens
- ARTutor
- 3DBear
- BlippBuilder
- Jig WorkShop (only available to iPhone users)
- Vidinoti
- Onirix
- Metaverse
- Sketchfab AR

Most of these tools are introduced in the iPEAR toolkit of educational AR apps, which stresses the importance of this toolkit that exists to support educators in their choice.
Many technical issues hinder students' performance: No Wifi, too many tools to choose from, lack of training, compatibility issues, lack of mobile devices, vague assignments, and reluctance to share and experiment. No app helping page, clear expectations, and an inadequate description of the task. No educators interventions. Cost of devices. Inappropriate use of tools uses AR for photo editing, overloading batteries, and data consumption.
Some educators managed to solve these issues creatively with inclusive praxis. They urged their students to share devices, ideas and roles within the peer groups so that all members could contribute. Others believed that technical issues were complex or that the assignment needed more careful planning. Lack of training with AR, stable internet connection and effort to invest more time in an innovative approach created a negative predisposition to try something out of the ordinary.

Students' engagement & excitement

The positive impact was also significant in engagement. One educator indicated: *I have noticed that during the iPEAR approach, all the students were engaged and excited about using AR tools and working as a team. The iPEAR approach promotes brainstorming and critical thinking for students. As a result, this made the lesson more interactive and students engaged for extended periods.*
Social interaction as a form of engagement was a rewarding process as extrinsic motivation. In other words, students liked working with their friends and classmates more than listening to a lecture in class or online, tried harder and were proud of their visual content. The teamwork quality and the interactions' harmony were based on group dynamics. Sometimes the peer-to-peer relationship was more democratic, while a mentor led the teamwork in another case. The decision about roles is based on the group dynamics and the students' personalities, and the responsibilities could be changeable over time. To further explain, the data showed that sometimes some students played different roles according to the assignment's needs or fellow students.
Visualisation was also a form that engaged students more since it is the language we all use online. Video, animation and all visual media products are designed to be attention grabbers. As one educator put it: *It was very apparent that the students were very enthusiastic at the end; they said that this was a great way of teaching. Students like working with peers and digital innovation and find iPEAR exciting - like visual learning.*

Students' empowerment/autonomy & reward through feedback

The approach allowed students to take more responsibility for their learning and with whom. Educators commented that the approach could positively affect students' professional development and lifelong learning: *All skills acquired by implementing this project might be used in their professional career*. Having such an experience, students learn by working with others and critically thinking about their performance quality. The good performances were rewarded with grades, comments, and praise from their peers.
Another comment describes the activity*: They meet regularly, talk about it, and give each other feedback. So we have to say in a self-critical way: we actually have a student who really dealt with it, but who also wrote in the documentation that it motivated him and that he tried a lot and took a lot with him and that the feedback from the others helped him to keep going.*

Empathy and inclusive praxis as values in the instructional design

In some cases, students had no elaborate mobile phones or did not understand the iPEAR approach. Then, fellow students shared devices and ideas with an empathetic eye and worked inclusively. It is surprising that even underperformed students were engaged and worked collaboratively. Educator's comment: *It should be mentioned that mutual learning was a catalyst for integrating three students without mobile phones and without much sophistication in new technologies. The guidance from their fellow students helped them to participate and learn as well.*[1]
It is important to note that in other courses, the educators did not emphasise the inclusive nature of iPEAR. Either they did not implement the pedagogy or indicated that some students did not participate.

Training in planning

Based on the data, educators asked for and needed some training in the iPEAR approach planning to understand why it is helpful; they got a briefing from the iPEAR team on the pedagogical and the technical side of their case study; then they could persuade their students that it is worth the time they need to invest in the know-how of AR. Planning in terms of engagement, time and reflection process could substantially impact students' performance. For future applications of the iPEAR approach by educators, the iPEAR case studies and the present compendium will help them to find their role and to prepare students.

Educators' role

The educators need information about their students and their skills in using AR and mobiles before the iPEAR assignment. During the process, their roles need to be flexible in showing why and how an AR app could be utilised technically. Sometimes educators could be *a queen on a throne*, letting students work collaboratively and observe; in other cases, they could be *guides on the side*, mentoring P2P groups or *fellow travellers* learning at the exact times as the students. The barrier to the mixture of roles or tasks lies in the imagination of educators and their creative teaching repertoire to help students become knowledge workers and build their own learning paths, being mentors or responsible partners of P2P groups. It is important

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[1] Greek original: Πρέπει να αναφερθεί ότι η αλληλομάθηση ήταν καταλυτική για την ενσωμάτωση τριών σπουδαστών, χωρίς κινητά και χωρίς ιδιαίτερη επιτήδευση στις νέες τεχνολογίες. Η καθοδήγηση από τους συμφοιτητές τους, τους βοήθησε να συμμετάσχουν και να μάθουν και αυτοί.

to note that educators embrace inclusive values (no-one left behind perspective) to avoid marginalising underprivileged students (individual difficulties, compatibility issues, lack of pieces of equipment, etc.).

iPEAR design - future improvement

Educators highlighted that the obstacles lie more in AR technologies rather than pedagogy. To illustrate, they claimed that AR tools must improve to avoid battery or data overuse, be user-friendly, create more 3D models (images and domain-specific resources - programming courses, music etc.) and give more collaboration possibilities. It is helpful for the education community to have access to toolkits and manuals that clearly demonstrate the use of the tools, compatibility issues, the pedagogical implications and the costs. Labs for the benefit of technologies such as AR or XR need to be supported by Higher Education, while this research was based on the 'bring your own device' approach. Another way to improve the pedagogy would be to motivate the students to create visual representations rather than using ready-made resources. Time management of the iPEAR activity needs to be carefully planned depending on whether the task is online or in class. To top it all, updated professional development courses for educators and animated or game-like tutorials for the students could enhance the iPEAR practice. For educators' professional development, universities' organisational structure should be responsible. In many European educational institutions, digital skills and innovative approaches are enhanced due to educators' personal interests.

1.8 Reflections on the research

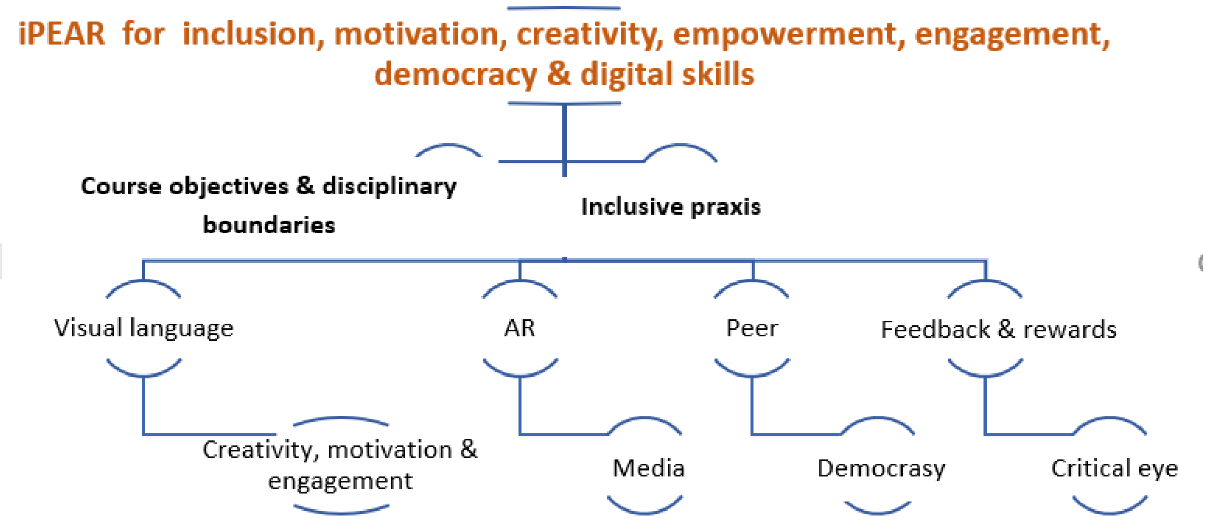

Figure 6: Thematic categories as macro-map.

Within the disciplinary framework educators could design tasks, promoting sharing of devices, ideas and content (inclusive praxis). The assignment needs to be developed taking into account the four elements: visual language (and media), AR tools, the peer groups and the feedback /rewards from peers and the course educator. If used effectively, the iPEAR model could motivate students to be more content creators, improve digital skills, participate democratically in peer groups and critically evaluate their work and their peers.
The hypothesis that the iPEAR approach is a practical learning method is confirmed based on the frequency of responses-inferential statistics. As a generic pilot study that aims to map the technology-enhanced pedagogical interventions, it shows evidence that the iPEAR approach could enhance students' interest, motivation and empowerment in a broad spectrum of courses from students' and educators' perspectives.

Students' perspective on the iPEAR approach was cumulatively positive, despite the various tools and disciplinary boundaries. The tasks have been applied to archaeology, history, medicine, graphic, design, and photography courses, to name a few. Students used simple tools such as QR codes, mobile or web-based apps and elaborate devices such as HoloLens. They felt engaged, motivated and empowered to work creatively with their 'leaning buddies' to explore AR, visuals and human-to-human relationships. Brainstorming creative ideas was evident. They strongly recommended further exploring the pedagogical model in different courses and disciplines. The pedagogical model promotes gameplay, visualisation, wonder and discovery learning instead of boring lecture time. The valuable acquisition of digital and cooperation skills could be applied in their future career.

The side effects of the iPEAR approach should be addressed as well. The biggest obstacle that hinders the process is the so-called **technical divide**. Some devices, such as HoloLens, are expensive to be bought by institutions. The Bring your own device (BYOD) perspective causes difficulties due to socioeconomic status. Some students have elaborate smartphones that support AR technologies, while others may need help to afford to buy such devices. Compatibility issues arise with some devices as well since there are significant differences, for instance, between apple and android devices.

Some students claimed that they needed more **training**, a manual or **better instruction by the educators t**hat could frame the activity concerning the learning objective of the course and the **quality of communication with their peers.** Few participants were hesitant **to use new technologies** and preferred traditional teacher-centred approaches. Some more issues are **tiredness or headache from using visuals for an extensive period**, such as the case of HoloLens.

From an educator's perspective, iPEAR effectively motivates students to work with new technologies, and social collaboration is also rewarding. As an agent of their learning, the student explored creative paths and understood the importance of sharing as an inclusive praxis. Technical issues, students' insecurities about the level of difficulty of the assignments and grouped dynamics are elements of the visual instructional designs that need careful planning to make the iPEAR pedagogy effective in a specific time frame, either in class or online. Thus the students could find a creative portal to express themselves and acquire future-proof competence. Educators' training in pedagogy and technologies is imperative.

From the researcher's point of view, the categories are related to the data and could provide a pedagogical framework that offers more than initially thought. Besides motivation engagement and student agency, the iPEAR model could mirror critical thinking, democratic participation and the values of inclusiveness in the learning process.

1.9 Limitations & future steps

To start with the limitation of the research methodology, the importance of the informed grounded theory methodology lies in the assumption that researchers and educators could shed light on the potential of the iPEAR model. The research findings built the iPEAR pedagogy as a theoretical framework that educators could have as an option to use when they think it could be helpful. So there is no one-size-fits-all approach to education. Informed grounded theory is for theory building, not for theory testing.

The value of the methodology and, in parallel, the iPEAR pedagogical approach could be on the grounds of practicality and transferability. In other words, informed grounded theory (Themelis et al., 2022) is a never-ending refinement process. Educators could have the iPEAR options in their teaching repertoire to enhance engagement and promote student agency to their courses.

Moreover, the limitations of the iPEAR pedagogy could be categorised into four factors. First and foremost, the digital divide may create havoc for educators and their students. To further explain, the lack of devices in class and limited internet connection could hinder the use of the AR aspect. Another essential element is the need for more training for educators, and their students could create discontent when facing technical issues using AR apps or more complex tools like HoloLens. Educators' attitudes towards technology and collaborative methods could significantly influence student outcomes. Without a doubt, creative solutions, sharing of devices and collaborative netiquette could solve some of the challenges of the iPEAR pedagogy. Last but equally important is the reward system for inclusiveness and peer-to-peer learning that could motivate students to engage more and mirror positive behaviour for democratic participation in education.

Shortly, new apps and tools mixing the physical and digital world harmoniously are invented, making implementing the iPEAR pedagogy easier. Further research could shed more light on how visual learning could enhance understanding, memorisation and creativity. Pedagogies promoting students' choice and empowerment are future directions that could lead students to be self-directed, life-long learners.

1.10 Conclusions on the research design

With so many students dropping out of schools or universities during the pandemic, growing marginalisation of the poor in society, psychological and physical well-being in danger, and so many modern jobs requiring advanced digital skills, there has never been a more critical time to figure out new pedagogical paths. The after-Covid era calls for innovative and resourceful ways to promote inclusiveness, social learning and digital skills working harmoniously together to make students feel empowered lifelong learners that care for their peers.

To enhance students' creativity, engagement, motivation and empowerment, the iPEAR project chose to design innovative digital tools such as AR with collaborative learning-P2P. The research findings showed – with specific limitations already discussed – that the theoretical framework can promote a more satisfying learning experience for students while reaching particular learning outcomes. As technology advances, more user-friendly devices will be built, and a lifelong learning mindset could make students and educators fellow travellers in the quest for knowledge and digital skills.

The dependability, confirmability and audit trails of research are shown via the participants' quotes and the statistical data documented. The reflection section and the macro-map of the relation between categories (Figure 2.) keep a self-critical account of the research process.

The research findings guided the pedagogical strategy, assessment framework and assessment tool developed in the intellectual output IO3. The case studies presented below as examples could enhance awareness of the potential of the iPEAR approach.

2. iPEAR case studies

The following case studies could be a source of inspiration for educators. The criteria for the specific cases chosen are:

1) Digital innovation for cases developed in academia and the learning sector
2) Free-to-use tools for inclusiveness
3) Students’ and educators’ preferences from the case studies of the research process
4) Cases from MOOC participants that created resourceful scenarios

It is important to note that educators designed the cases for the research process without any guidance. In contrast, the MOOC participants have studied pedagogy and the guidelines specified by the research findings.

2.1 Digital innovation: pioneers in the field of AR develop apps and design content

The case of NTNU - Norway (An Educational AR Tool for Neuroscience and Medical Education): AR-Based Peer-Learning with HoloLens 2 and Android Devices

Teaching neuroanatomy physiology requires a detailed understanding of the brain's anatomical structure. Hybrid learning was adopted at NTNU because of pandemic regulations. This approach encouraged exploring new ways to deliver learning content and, more importantly, to offer possibilities for peer-to-peer socialisation among students. Students highlighted the lack of social contact as a negative consequence of online teaching. Another factor was to investigate techniques for exploration of the brain structures, for example, different uses of cutting planes instead of using physical brain tissues for dissection.

The AR application is an improvement over a previous application created for single-user VR. The new application was developed as part of a master's project in collaboration with a lecturer in neuroanatomy at NTNU. The Nevrolens app developed for HoloLens 2 enables visualising and manipulating a digital rat's brain generated from MRI scans, and the brain structure can be separated into relevant physiological units.

From the perspective of peer and hybrid learning, it was essential to have the possibility of a shared view of what the user (either a lecturer or a fellow student) wearing the HoloLens 2 headset could see. It is still common for many AR apps for a headset that only the user wearing the headset can see what is happening. This makes it challenging to share their experience with others either in the same physical space or remotely. The Nevrolens AR app addresses these requirements: one user could interact with the digital brain and manipulate it, while the other could see the manipulation's consequences (see Fig. 3).

The content can be seen simultaneously by users with the HMD (s) and others using Android smartphone (s) (serving as a low-cost alternative for HoloLens). Both HoloLens 2 and Android users could manipulate the holographic brain. In addition, Microsoft/HoloLens 2 introduced the Windows device portal, a helpful feature to stream the app to a monitor. Supporting Peer-Learning with Augmented Reality, five individuals could participate in a session. One lecturer or student can therefore explain to classmates the topic at hand. Since they have a shared view of the brain structure, students can explain to each other, manipulate brain parts, point, and show. A usability study was carried out with several participants to evaluate the AR.

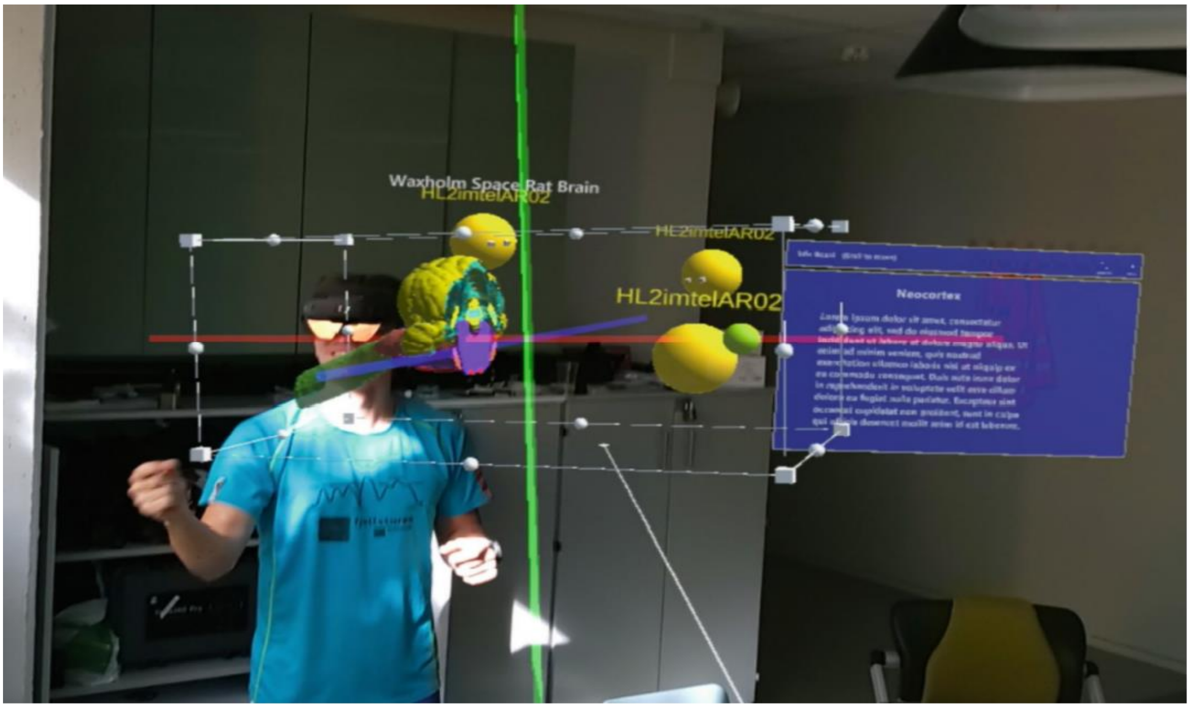

Figure 7: A tester interacting with a colleague while performing a brain dissection using the Nevrolens application.

2.2 Free-to-use tools for inclusiveness

The case of IHU - Greece: ARTutor

The AR Tutor platform is one of the 8 proposed in the iPEAR project for educational use. It is important to note that ARTutor is a FREE educator platform.

In the Online Training Program on Immersive Technologies for Education (ImTech4Ed), ARTutor was introduced and utilised in the short training program Online Training Program on Immersive Technologies for Education, under the Erasmus+ program Immersive Technologies (ImTech4Ed)", which focuses on the application of augmented and virtual reality technologies in STEAM education.

The training involved students, researchers, and teachers and was available remotely. It included asynchronous activities (e.g. educational content study and exercises) and 5 online meetings.

The training was attended by teachers of different STEAM domains and students from other study programs (computing, game design, arts, humanities & social sciences) in universities of various European countries (Cyprus, Greece, Germany). In this way, the creative content was combined with the possibility of cultivating "21st-century skills" concerning creativity and the ability to operate and collaborate in heterogeneous groups.

Figure 8: Logo and potential of ARTutor.

During the 2nd International Hackathon of the ImTech4Ed project, which took place from 6-10 December 2021, 32 students participated, divided into seven groups to work collaboratively towards developing a specific STEAM educational project with the use of immersive technologies. Additionally, 2 mentors and 2 researchers/teachers also participated.

In the below-listed table, the projects are presented:

Group Number	Project name
i	Accordo di Musica
ii	Learning About the Road Signs
iii	League of Legends Instructor
iv	Local History Game
v	Learning about Animals
vi	Invincible Enemy Made Visibly
vii	Chess Openings

Table 1: Results of the 2nd International Hackathon of the ImTech4Ed project.

Each project reached a high level of the "ready to play" development stage, given the short period of the event. Some representative screenshots of the projects follow. Overall, participants (students and teachers) stated that they enjoyed participating in the hackathon and were satisfied with the process. They were motivated to complete their project for the hackathon 62,5% and believed that what they learned about AR could positively affect students' learning (87,5%).

2.3 Students' and educators' favourite experiences on iPEAR research

Case 1 of FAU - Germany: Sketchfab AR for a deep dive into the world of the ancient Christian world

In a proseminar, students examined the subject of the Roman catacombs. With the help of AR, they dealt with the facilities' structure and scenic design. The models they used were all on Sketchfab.

FIGURE 9: The treasure hunt task sheet.

Figure 10: Avatar and QR-Codes.

In a pen & paper-based quiz **treasure hunt**, they hunted a relic and answered quiz questions. Each quiz question could be solved by either an AR application or a 360° video. A **QR code** led the students to the models. Alternatively, they could use a link to it because it was an online session, and students would like a link to click on. An avatar led them through the tasks, giving them additional hints if needed, hidden in another QR code. The students worked in groups of four people. In these groups, students at the very beginning were mixed with advanced students. Students in the groups were from different study programs as well. The students worked on the treasure hunt together in these small groups but in competition with the other groups. The search took place in a Zoom session before Christmas, and the educator jumped from room to room and observed that some groups were very supportive of each other. For example, there were technical problems with the internet connection, as these Sketchfab models are time-consuming to download. They shared their screen and showed each other what was there. Many also went into a good discussion justifying their answers.

Additionally, one of the students presented the catacombs of Naples with the help of 3D models. She showed a model, and when she talked about certain burial chambers, she also displayed **QR codes;** thus the classmates could call the burial chamber on their smartphones or other devices. Educator's remark:

> *Then they really pulled out their cell phones, scanned them, and were actively involved in the material. They would have liked to have had more time to closely examine the chamber. She had a time frame in her paper and couldn't do much about it. But that worked very well in itself. Her fellow students actively followed the presentation with great motivation and engagement.*

Case 2 of FAU - Germany: Creating an e-learning module with MetaVerse

Students of media science and educational sciences met in an introductory course to media theory and media didactics. In this course, their task is to work in peer groups on a media-theoretical approach of their choice and to develop an e-learning module based on this approach. One group of students developed an e-module on the media theory of Marshall McLuhan and combined it with the technology of AR. McLuhan, in, his theory, did not deal with XR as this technology was not developed in his time; he mainly dealt with the visual media form of television. The student group decided to implement McLuhan's theory with AR technology, adding an example augmentation to their e-module and linking it to the media theory of McLuhan that "the medium is the message". The augmentation shows an old television showing image noise:

Figure 11: The media theory of Marshall McLuhan combined with the technology of AR.

The student developing the concept confirmed that this activity motivated him and that the feedback from the peers helped him keep going. He was fascinated by the technology of AR and said that "*Now I've not only done an e-learning module, but I've produced something futuristic myself.*"

Educators' remark:

> *The group decided together, with some advice from their lecturers. Initially, it needed to be clarified what role Augmented Reality should play in the e-Learning Module. Still, it turned out that the group took Marshall McLuhan's theoretical approach as a topic and then took Augmented Reality as an application example. The group with AR was one of the committed groups, thanks to the iPEAR approach.*

Case 1 of AKTO - Greece: Using 3dBear and ViDinioti AR for the understanding of marketing design

An instructor of **graphic arts and multimedia** designed an activity with iPEAR pedagogy to enhance her understanding of marketing design. The students could add images, audio files, videos, animation, and 3D objects on advertising labels they have already developed with their peers during the course. As a learning outcome, students had to narrate a story about the advertised products or services. Also, students could scan a printed image on their devices and reveal AR information about their project. 3dBear and ViDinioti AR were the tools used in the activity. The iPEAR perspective enhanced collaboration, creativity, and student satisfaction. The fast exchange of feedback and efficient communication was the key mechanism that triggered enthusiasm and practical experimentation with new approaches and tools. Lastly, but equally important, students felt empowered to work with their peers, get organised, manage their time and resources, and evaluate their assignments.

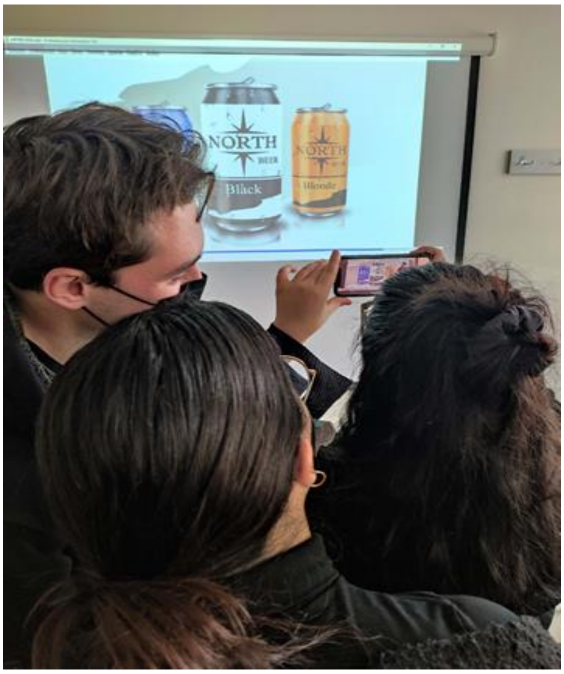

Figure 12: Students using AR in the context of the training of Electronic Model Processing and Graphic Design for Multimedia. (copyright: AKTO)

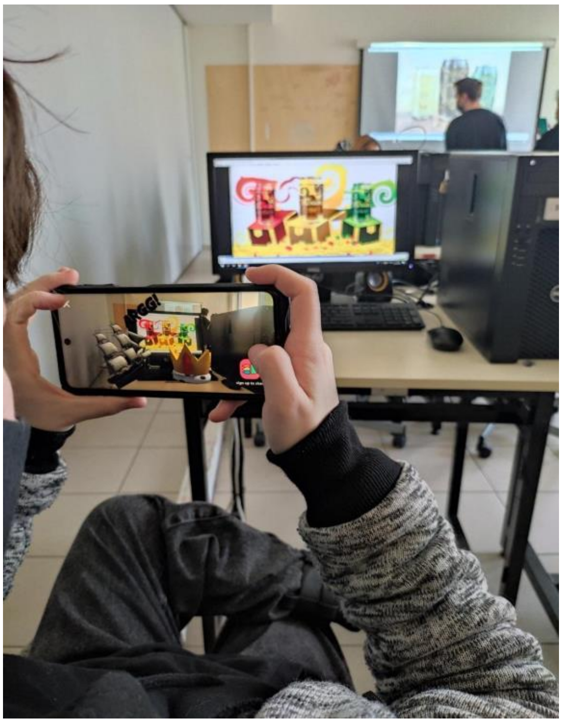

Figure 13: Students using AR in the context of the training of Electronic Model Processing and Graphic Design for Multimedia. (copyright: AKTO)

Case 2 of AKTO - Greece: Using AR for Interior Design

A group of first-year interior design students was instructed to us AR in a setting of learning collaboratively. They had to decorate the veranda of their classroom for Christmas using AR. Educator's remark:

This task taught them to collaborate, see the benefits of peer-to-peer learning, and develop AR skills.

Figure 14: Students decorating the veranda of their classroom using AR. (copyright: AKTO)

2.4 The experience of MOOC participants

[case studies of MOOC participants will be added here]

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List of Figures

List of tables

Appendix 1: Interview Questions

Research questions for the semi-structured interviews with educators:

A.

1) What was the learning objective of the course unit?
2) Was the objective reached?
3) Could you describe the task that students learn with their peers (peer -to peer learning) and use AR tools (iPEAR intervention)?
4) Did the combined AR and peer learning approach help reach this objective? How did it help?

B.

1) Does the iPEAR approach/intervention improve students' **motivation** (to learn)? If yes: How?
   [students like working with a peer, like innovation, find it exciting, like visual learning]
2) Will the iPEAR approach/intervention improve students' **engagement**?
   [excited about using the tools and working with peers]
   How?
3) Will the iPEAR approach/intervention improve students' **autonomy/empowerment?** (giving students knowledge and skills to pursue their future professional interests) How?
4) Will you use the combined peer learning and AR approach again?
5) How could it be improved?

Appendix 2: Survey questions

Research questions for the online survey for students (Likert scale 1-5)

1) Did you find the approach of peer-to-peer learning combined with AR tools satisfactory?
   a) Very satisfactory b) Somewhat satisfactory c) Neutral d) Unsatisfactory e) Very unsatisfactory

Why?

2) Were you more interested in teaching each other and sharing content with your peers and AR tools?
   a) Extremely interested, b) Somewhat interested, c) Neutral, d) Not very interested, e) Not at all interested

Why?

3) Did this learning approach make you feel empowered (more responsible for your learning)?
   a) Very much b) Somewhat c) Neutral d) Not really e) Not at all

Why?

4) Do you think it would be useful in other courses as well?
   a) Always, b) Sometimes, c) Once in a while, d) Rarely, e) Never

Why?